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Forthcoming Events.

MAY 7.

British Foundrymen's Association (Lancashire Branch).—Annual meeting.—Open discussion on Foundry matters.

MAY 28.

British Foundrymen's Association (Birmingham Branch).—"Production of Locomotive Cylinders," by H. Pemberton.

NOTES AND COMMENTS.

A Well-Known Bell Criticised.

Speaking at the Royal Institution, London, on April 8th, on the subject of bells and bell tones, Mr. W. Wooding Starmer offered some criticism of the bells in the tower of the British Houses of Parliament. Referring to "Big Ben," the speaker said that the tone the bell gave was not so good as it should be. It had been badly used, as nothing but serious injury could result from the cutting of holes in the sound bowl, as had been done. It was said that the holes were cut to ascertain the extent of a crack. There was no doubt that the crack only extended partially through the sound bowl, but to what extent it injured the tone it was difficult to say. However, it was certain that the holes and the crack, apart from any other considerations, seriously marred the tone of the bell. He sincerely hoped that the day was not far distant when the authorities would cause the bells to be recast, and see that they were not only sound castings, but perfectly tuned before they were fixed in the tower.

As there is probably no better known bell in all England than "Big Ben," it is a matter of considerable interest to bell founders to find that worthy being criticised in this manner. It is fairly well-known that the bell is cracked to some extent, which accounts for the criticism that the tone is not all it should be, but it still ranks as one of the finest specimens of bell founding to be found in London—that is, if the bell be considered as it first came from the foundry.

The Defects of "Big Ben."

In connection with the charges which have been levelled against "Big Ben" it is interesting to recall the history of the casting of this, the largest bell ever cast in London. Originally it was cast at Stockton-on-Tees, but during the testing in Palace Yard it cracked, and was consequently never hung in the tower. The bell was broken up and the metal sent to the foundry of Messrs. Mears and Stainbank, Whitechapel, where it was again cast, this time successfully, under the personal supervision of Lord Grimthorpe, who also arranged for the hanging of the bell. The result was a fine casting, weighing 13 tons, 10 cwts. 99 lbs.; but unfortunately the hammer used for striking it when first hung, which weighed 8 cwts., proved far too heavy. Eventually a hammer half that weight was substituted, but in the meantime a flaw had developed as the result of using the too heavy hammer, and in order to ascertain the extent of the damage that had been done a number of holes two inches deep were drilled in the sound bowl—the thickest part of the bell near the rim, on which the hammer falls. No bell, of course, could stand such treatment and still retain its perfection of tone. As it is it can be heard nine miles away, its note, E natural, carrying for a great distance, despite the roar of London's traffic.

Bell-founding does not appear to have undergone much change or development for some centuries; the

furnaces employed and the mixtures of metal used, certainly, are superior to those of olden times—in fact, were "Big Ben" to be cast to-day, a much better bell would in all probability be turned out—but the methods of moulding are almost the same. Practically the same loam moulds are used, and they are swept up and cast in the same manner.

Some Other Famous Bells.

While "Big Ben" ranks as the largest bell cast in London, "Great Paul" of St. Paul's Cathedral, which was cast at Loughborough in 1881, is heavier, weighing 16 tons 14 cwts. 75 lbs., with a diameter of 114¾ inches. The Whitechapel foundry also produced another famous bell, "Peter," of York; this was cast in 1845, and weighs 12½ tons, with a diameter of 7 ft. 4 in. Some other historic bells are "Great Dunstan" of Canterbury, weighing 3½ tons, which was recast in 1762 from an old bell, originally the gift of Prior Molass in 1430, and "Great Tom" of Oxford. This latter bell was recast in 1612 and again in 1654, and after three unsuccessful attempts to recast it again this was finally done in the year 1741. Perhaps the bell most renowned in history is the great bell of Moscow, which is said to weigh nearly 200 tons, and was cast in the year 1734; but as it is now cracked and useless it gives place as the world's largest bell to one cast in Osake, Japan, in the year 1902. This bell weighs over 150 tons, and measures 26 ft. in height, 16 ft. in diameter, and over 18 in. in thickness in the thickest part.

Bell Metals.

Of the mixtures used to cast the great bell of Moscow and the Japanese bell mentioned above nothing is known. Modern bell metals for large castings consist of approximately 80 per cent. copper and 20 per cent. tin, though for smaller bells the amount of tin is sometimes increased up to 50 per cent. Other metals have also been introduced into the alloy with the object of improving the tone, and it is a common fallacy that a percentage of silver has this effect. A small percentage of iron is probably a more useful addition; one writer describes the success attained by the addition of a small amount of iron (about 0.5 per cent.) in the final metal through the medium of yellow prussiate of potash. Iron has often been advocated, but it is a difficult metal to introduce in the metallic form, as it does not readily form a homogeneous mixture when copper is present. The composition of bell metals, however, varies greatly; in fact, by varying the shape of the casting the majority of fairly hard alloys can be used for bells, though, of course, the results would not always be so satisfactory as with the recognised bell metals. As an example of the departures from the orthodox mixtures may be mentioned a bell metal patented by a prominent American firm of brass founders and bell manufacturers. This mixture consists of about 76 per cent. copper, 19 per cent. zinc, and 5 per cent. tin, and gives a metal that will rather bend than crack. The tone, too, is said to be equal to the copper-tin mixtures. The truth is the tone of a bell depends more on the design and the care exercised in casting it. The presence of oxides in the metal spoils the tone, and it is therefore necessary to keep the metal as clean as possible. This is borne out by the fact that a good bell metal will lose its resonance on being remelted several times. It is possible, also, that the good tone obtained by the use of yellow prussiate of potash to introduce a small percentage of iron, as mentioned above, resulted more from the fluxing and cleansing action than from any alteration in the actual composition of the metal.

The Properties of Foundry Coke.

On probably no other matter connected with the foundry do we find opinion so divided as is the case in regard to the requisite physical properties of foundry coke. It appears that the old rule that a good coke should be sufficiently dense to sink in water is not borne out by experience; the metallic lustre, too, which has always been regarded as an indication of a good coke, is not an essential feature. Provided the coke is sufficiently strong to support the weight of the charge in the cupola, the lighter and more porous it is, the better it will burn. There is, of course, a point at which increased porosity involves insufficient strength, but according to the nature of the coke this may or may not mean that the density must be so great, in order to give strength, as to make the coke sink in water. The better classes of coke often float with about one-third of the volume exposed above the water, though in many cases good results are obtained from dense cokes which sink. On the other hand, a coke which floats may be so weak as to be unfit for use. So the foundryman is told that neither appearance nor the property of sinking in water are sure indications of quality, and with his pet theories, and tests discounted in this unceremonious manner, it is small wonder he cries out for some practical and reliable test. In the face of all the difficulties, he is perhaps wisest who finds by experience a coke which suits his work, and sticks to it. In the meantime, while acknowledging the necessity of chemical analysis for ascertaining the sulphur content, we wait the arrival of some really practical and reliable method of testing the strength and porosity of coke—a method which can be applied in the foundry without great expense or waste of time. The worried foundryman waits to bless the inventor of such a method.

Forthcoming Annual Conference of the British Foundrymen's Association.

At a meeting of the Council of the British Foundrymen's Association, held in Birmingham on Saturday, April 16, it was decided to hold the annual conference of the Association in August Bank Holiday week, at Manchester. The members had already voted almost unanimously in favour of this course. The meetings will take place as usual on Tuesday and Wednesday following Bank Holiday, and various excursions will take place on the Thursday. About five Papers are to be given, including one from Mr. Blume, representing the General Electric Company of Sweden, on the subject of "Swedish Malleable Iron." The arrangements are in the hands of a local committee, of which Mr. R. W. Kenyon is chairman and Mr. H. Sherburn is secretary. A number of visits will take place, and as trade is now active it is expected that several large foundry establishments will be in operation and available, and it is hoped to visit, among other places, the fitting shop of the Lancashire & Yorkshire Railway. It is expected the attendance will be larger than ever, owing to the considerable accession of membership during the year. The scheme adopted at the last conference for the classification of members has brought new members in all departments, and among the new branches represented will be the Glasgow branch, lately formed under very promising circumstances. It is expected that Glasgow will become a very important branch in the future. Much satisfaction was expressed at the meeting of the Council in Birmingham on April 16 that the finances of the Association, notwithstanding the heavy expenditure involved by important new departures launched during the year, were in a strong position, and the year will close with a small balance in hand.

Casting Stereotype Plates.

The Journal of the Franklin Institute for February last contains a very interesting paper, by Henry A. Wise Wood, on "Modern Stereotypy and the Mechanics of the Newspaper," from which we take the following particulars relating to the production of stereotype plates for printing:—

Printing began with the making of handcut blocks, which were used to stamp their similitude upon other surfaces. Later, blocks called type bearing each a single character were made, and these when combined one with another produced words, which, when gathered into sentences and paragraphs, became the page. The great impetus given the typographic art by the introduction of "movable types" was due to the ease and economy with which text could be prepared for the press, and after printing the type page be resolved again into its component characters, which thereupon were fit and ready for further use.

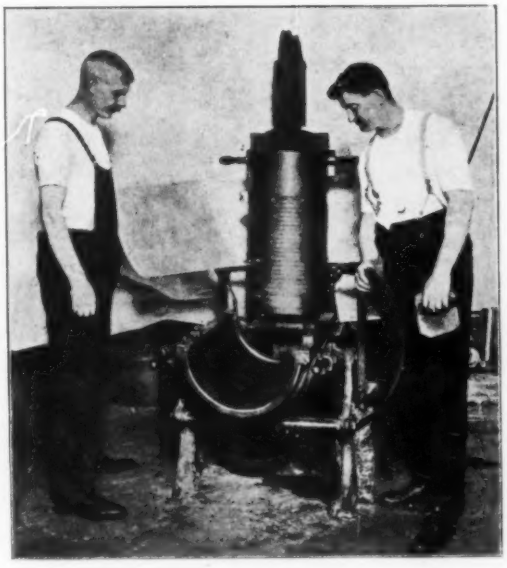


FIG. 1.—SETTING THE MATRIX.

FIG. 2.—FILLING THE CASTING BOX.

The work of cutting characters being slow and costly, recourse was soon had to casting them, of an alloy of lead, antimony, and tin from moulds, now called matrices. These were made of plaster from types or dies which had been cut by hand; and later of copper from harder dies which, upon being driven into it, left their impress. Until recently the driven matrix was exclusively used; but nowadays the manufacturers of type cut their matrices by means of a power-driven engraving device, the controlling lever of which is guided by hand along the edges of a large template, or raised representation of the particular character to be cut. Thus by means of the Benton-Waldo machine unskilled men, working with great rapidity, can produce the most intricate matrices at little cost. When matrices are required to be made in large quantities, as for use with the type-making and composing machines of the modern printing office, they are still driven, the dies, or "punches" employed, being engraved by the Benton-Waldo method. The matrices of extremely large type-sizes which are now upon the market, are usually neither punched nor cut, but are electrolytically-deposited copper impressions of existing types.

The substitution of curved stereotyped printing plates for type gave to the newspaper two new advantages. Many presses could be used; and these could be run at higher speeds than were possible where printing surfaces were made up of individual types which were held to a cylinder merely by wedges. Bullock, of Pittsburg, was the first to offer a press which properly utilised these advantages, and his machine quickly came into general use. Hand-fed machines for folding newspapers were already in vogue, so it was but a short step to the attachment of such a folding machine to the press itself.

The newspaper now depends upon the co-operation of three important mechanical departments: the composing room, the stereotyping foundry, and the press-room. The great importance of the art of stereotypy will be seen by comparing two newspaper offices, the one without, the other having, the advantages which stereotypy confers. In the first the type, clamped in curved frames called "turtles," may be used upon but one press. The turtles having been secured in place and the machine started, in the course of an hour's time 10,000 copies, or at most 20,000, are produced and distributed. In a modern metropolitan newspaper office will often be found combined in one form or another from forty to sixty complete perfecting printing mechanisms, and within twenty minutes after the arrival at its stereotyping foundry of the last page of type, all the presses are fully supplied with printing plates. The importance of the art of stereotypy is plain when it is realised that by means of it a plant containing sixty press-units is now pos-

sible, and that such a plant is capable of producing the equivalent of from seven to ten hundred thousand eight-paged newspapers an hour.

In 1890 the art of stereotypy was being practised exclusively by manual means. But a few devices, power-driven and hand-controlled, had been provided

FIG. 3.—OPENING THE CASTING BOX.

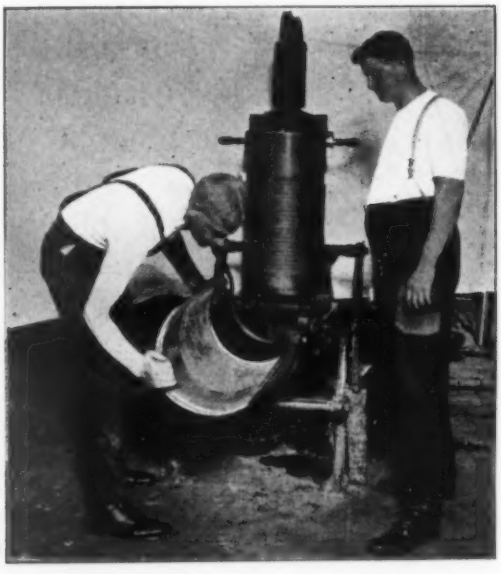


FIG. 4.—REMOVING THE CAST PLATE.

to facilitate its work. One was used to remove the riser or sprue of the freshly cast plate, while another, when the plate had been dropped into it by hand, served to smooth out the plate's inner, or seating, surface. In but one other function was the work of the hand assisted by power. The moist papier-maché sheet, or "flong," as it is called, after it had been laid upon the type-page and covered with a felt pad, was moulded to the face of the latter by an iron roller beneath which it was drawn upon a bed propelled by power. Excepting these, all of the operations of stereotyping required the direct employment of the thought, the eyes, and the hands of workmen.

The process of stereotyping then in vogue may briefly be described as follows:—To prepare the flong two blotter-like sheets of paper were pasted together, and upon one side of these four sheets of close-fibred rice-straw tissue were pasted. The paste used, its composition then a trade secret, was of flour, a clay, and a germicide, the latter to prevent fermentation. Flongs enough were made for the next day's requirements, and these were allowed to season in a moist place. As each type-page reached the foundry a flong was laid upon it, tissue-side down, and upon the flong a closely-woven stout felt blanket. Page flong and blanket were then run beneath an iron roller, the operation of moulding thus being performed. Before

FIG. 5.—STRIPPING THE MATRIX FROM THE CAST PLATES.

the advent of the moulding-press, the flong was beaten into the face of the type-page by long-handled brushes—a slow process, which the roller superceded. From the moulding press the type-page with its moulded flong (now become a matrix) still clinging to its face, was carried to a steam-heated iron table where, the moulding blanket having been exchanged for several layers of dry soft blanketing, an unheated iron plate or "platen" was screwed down upon it. Heat, thus applied to the type, drove all moisture from the matrix into the blankets, and usually in from four to six minutes the matrix, or "mat," as it is usually called, became dry and was ready to be cast from. In the eighteen years that have since elapsed this process of moulding and drying has undergone but a slight improvement. Better paper and paste have increased the durability of the matrix, and an improvement in technic has made it more sensitive to the delicate "effects" of modern illustrations; but, if a slight reduction of the time consumed in its making be excepted, the process of

matrix-making has scored no substantial gain. Of progress in the making of plates, however, a different story is to be told.

When stereotyping was first adapted to newspaper printing, certain implements were necessary in order that suitable printing plates might be made. The employment of the rotary press required that the plates be curved. It was also requisite that they be of uniform thickness, and that their curved ends be bevelled so that they might be held by clamps to the cylinders of the press. These conditions necessitated the use of a curved casting-mould, or "box" as it is called. In this the paper matrix was bent and clamped. The mould was then closed, a hinged semi-cylindrical core acting as cover, and into it a ladleful of molten stereotype metal was poured, by two men who had fetched it from a nearby cauldron. After the appropriate time for solidification had passed the mould was opened and the casting, with its clinging paper matrix, removed. Then the delicate operation of stripping the matrix from the face of the cast was cautiously performed, and the matrix was returned to

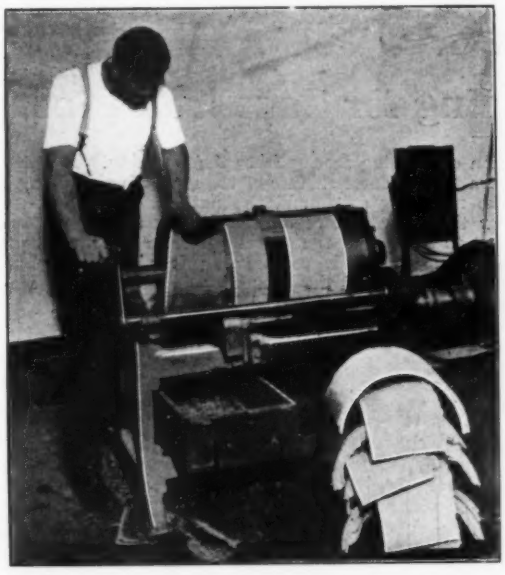


FIG. 6.—CUTTING THE RISER FROM THE CAST PLATE.

the mould and repositioned for another cast. Meanwhile the first cast was placed upon the cylinder of a "cutting-off" device, where, after having been nicely positioned and securely clamped, it was turned beneath a power-driven rotary saw and its riser, or rough upper end, removed. The saw of this apparatus was so shaped that it left the curved edge of the cast bevelled. The cast was then turned and its other end passed beneath the same saw, in order to insure to it likewise a satisfactory clamping surface. The cast was then inverted, and dropped face-down into the hollow of a "shaving-out" device, in which a rotating straightedged knife served to smooth or plane its inner surface, and to give it an accurate thickness. In order to reduce the surface thus needing to be planed it was customary to construct the core about which the cast was to be made with narrow circumferential grooves, set an inch or so apart. In the casting operation these grooves were reproduced upon the inner surface of the cast as ribs, or finishing strips, and furnished a surface which, when planed, was ample to support the cast plate under the pressure of printing. After it had been shaved the cast was next set, face up, upon a fixed cylinder, or "horse," where two men, with hand-plane and chisel, removed from its edges all super-

FIG. 7.—PLANING THE INNER SURFACE OF THE PLATE

FIG. 8.—REMOVING SURPLUS METAL FROM THE SURFACE OF THE PLATE BY CHISEL AND PLANE.

fluous metal, which might otherwise take ink and print. This was called "finishing." From the finishing horse the cast plate was next carried to a trough and cooled, and thence to the press-room

where it was dried and clamped to the cylinder of a press. All of these operations, save only the propulsion of the cutting-off saw and shaving knife, were performed by hand. And for each plate made every function, from the precise positioning of the matrix to the drying of the finished plate, had to be repeated.

The casting mould was a heavy and clumsy piece of apparatus, which consisted of back and core, a bottom "ring," beneath which the lower matrix-edge had to be clamped, two side-bars which had then to be laid upon the straight sides of the matrix to hold it in position, and clamps for finally locking the halves of the mould together before it should be stood on end to be filled. Two men were required to insert and position the matrix, and put the mould together, and likewise to take it apart after its contents had cooled, and removed the cast and matrix. Another man was required to cut off the riser, a fourth to shave the plate, a fifth and a sixth to "finish" it, and still another man to dip it. The rapidity with which such a crew could work, with a single casting mould, was at the rate of a plate in every minute and a half. Thus in order to produce ten plates from a matrix, or enough to supply five quadruple presses with the plates required to enable them to print a single page, from fifteen to twenty minutes were consumed. If, in an office having five such presses, an eight-paged paper was to be run, eighty plates had to be made, the casting and finishing of which consumed nearly two hours if but one casting box were used, or half the time if two, as was the custom, were employed.

As the circulations and bulk of newspapers increased, sixty unit printing mechanicisms, each requiring perhaps sixteen printing plates, ceased to be a rarity, and the pressure of plate-making became intolerable in the offices of the large metropolitan journals. Nevertheless, up to the close of the last decade of the last century, the process of stereotyping was carried on in the primitive manner described, and entailed the performance of hard manual labour under injurious conditions of temperature and haste.

(To be continued.)

German Methods of Moulding for Cast-Iron Pipes.

In a recent issue of "Stahl and Eisen" there appears an article by Gustav Simon, on "The Manufacture of Cast-Iron Pipes," wherein the author points out that cast-iron pipes have not only to withstand internal pressure, but also shock (both internal and external), and the action of the material in which the pipes are laid. The article proceeds to describe several German methods of pipe moulding, and also the system of Messrs. R. D. Wood & Company, Philadelphia, which is particularly adopted to the smaller diameters. An abstract of the descriptions by "The Iron Age" contains the following particulars:—

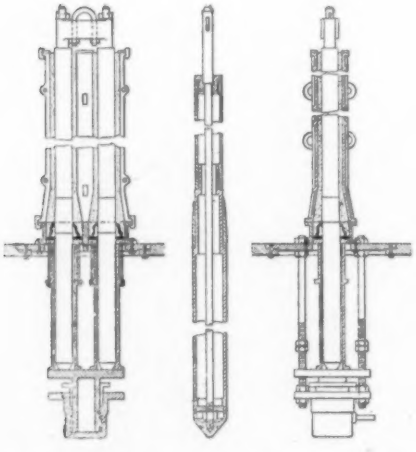
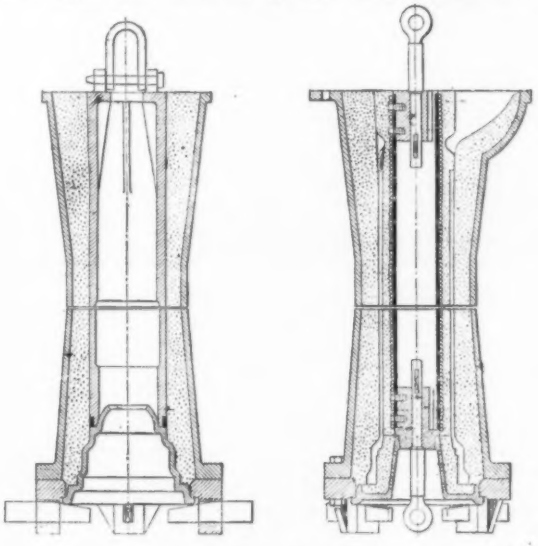


FIG. 1.—WOOD & CO.'S METHOD OF MOULDING CAST-IRON PIPES.



FIGS. 2 & 3.—GERMAN METHOD OF MOULDING PIPES.

Regarding Messrs. Wood & Company's system, Fig 1 shows the moulds made in couples. The operation of drawing accomplishes the ramming. The pattern for the outer surface of the socket is pressed into the moulding sand, and the pattern—the plunger—for the outer surface of the body of the pipe is set just to the top of the socket pattern and then drawn through the sand, compressing it properly. The upper portion of the plunger being smaller in diameter and having a conical portion between it and the pattern part, when the plunger is drawn upward by hydraulic means the above-mentioned compression takes place. The illustration shows the construction of the pipe moulding machine. In operating this machine, the pipe flask is placed on the flask containing the socket pattern and connected with it. Loose

sand is now dropped into the flask. The valve being opened, the plunger rises to the distance of the lock nuts, which is just the height of the socket. The socket pattern is thus taken upward and pressed into the pipe flask. At the same time the plunger is pulled upward completing the mould. The plunger is now lowered and with it goes the socket pattern. It may be mentioned that the conical and lower portion of the plunger is a steel casting, as the wear is naturally very severe.

The German Method.

The German method of moulding is shown in Figs. 2, 3 and 4. The apparatus consists of a flask with centering device attached, a socket pattern, the pipe pattern proper, the socket core and the pipe core. The flask is of cast iron parted longitudinally and machined at the joints. It is also parted transversely in several places. Thus in case of accident it is

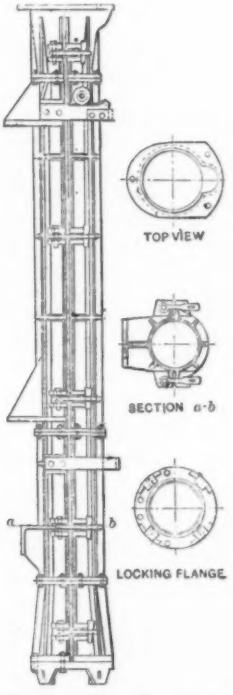
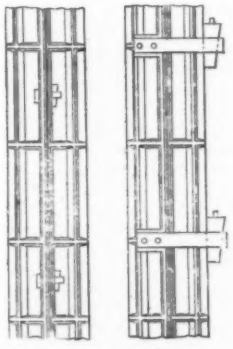
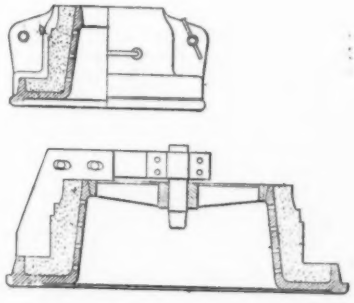


FIG. 4.—PIPE FLASK WITH SPECIAL LOCKING DEVICE.



FIGS. 5 AND 6.—FLASK LOCKED BY WEDGES.



FIGS. 7 AND 8.—METHOD OF MAKING SOCKET CORES.

cheaper to replace a broken section; odd lengths of pipe can be made, and it is possible to cast the socket upward if so desired. The wedging of the flask parts is shown in Fig. 4, which is an improvement on the usual methods illustrated in Figs. 5 and 6, and much to be preferred from the practical standpoint.

One half of the flask is fastened to suitable supports; the other is intended to be movable, for directly after casting the connection must be loosened to avoid casting strains in the pipe. The flask should be heavy enough and provided with ribs, as well as perforations to facilitate the escape of gases. The illustrations show the method of closing the bottom of the flask and the centering device giving the best results. It is needless to say that the flasks must be placed vertical and fastened securely during the ramming operation. The pipe pattern is of cast iron, carefully turned where the guides are touched as well as the sand. The socket pattern is first put up into the carefully closed flask, and fitted exactly into the centering flange. If this is not done, or the flange is loose, bad pipes will result. The pipe pattern is now placed on the socket pattern, and must fit squarely. A guide at the top is seldom required, as with proper care in ramming this is not necessary. After the flask is rammed up, the pattern is withdrawn, this requiring considerable power. To ease this up, the pattern is often made a trifle smaller in diameter at the bottom, or else, particularly in small pipes, a steel ring is shrunk on the bottom of the pattern and turned up conically, so that in drawing up the pattern a compression is exerted on the sand. The outer diameter of this ring will then give the proper size of the pipe.

After the moulds are blackened, the flasks are placed in the oven for drying. Drying with hot air is better than with the ordinary coke firing, having the advantage of a cleaner foundry, and is to be preferred even to drying by the use of gas. With hot air the drying can be done just where wanted and to the extent desired, which is not the case when an oven is used.

The preparation of the cores is the work of a special department. Where the pipe is cast socket downward, the core consists of two parts. The pipe core proper is placed on the socket core, the centering arrangement shown in the illustration serving this purpose also. Figs. 7 and 8 show the method of making the socket cores. For the smaller ones a cast-iron corebox in two parts is placed on the socket patterns. The large socket cores are swept up in loam, as shown. The pipe core proper is generally swept upon arbors. Only in some of the Swiss pipe foundries is ramming up with sand resorted to. The arbors are of cast iron, well supplied with perforations for venting.

Of late it has become the custom to pour pipes with direct metal, or rather a mixture of cupola iron and metal direct from the blast furnace. Usually direct metal with a relatively higher silicon content than the cupola metal is used, as this iron will hold its heat longer—a necessary procedure where the distance and the quantity taken to the foundry are great.

Dumping the flasks is an important item. In well designed foundries the same flask is used eight and sometimes ten times during a double turn. Attention is necessary so that the pipes may not be taken out too fast, for often very small things are the cause of unnecessary losses. The usual finishing operations are then carried out.

Foundry Management in Relation to Metal Stocks and Waste in Melting.

By Percival A. Richards, A.C.A.

(NOTE.—*The Editor has arranged for questions arising out of this article to be dealt with by the author, who will be pleased to assist any readers who require further information on the subject of metal stocks. Queries should be addressed to the Editor of The Foundry Trade Journal, as early as possible, if replies are desired in the next issue.*)

Accurate information relating to the stocks of metal of different qualities on hand at any time, and the weights of metal melted every week or month, is necessary to the ironfounder who desires to manage his foundry on the most economical lines. On account of the great weight and bulk of metal used, special methods are necessary in order to obtain this information.

Unless a system providing reliable figures is in operation, the taking down of metal stocks on hand at the end of the financial year is generally an uncertain and unsatisfactory operation. It is not practicable to weigh the stocks on hand, and it thus becomes necessary to estimate weights according to the bulk. In the case of pig-iron a reasonable estimate can usually be made by counting the number of pigs and then averaging the weights of a small quantity, thus arriving at the weight of the whole by calculation. This method is open to objection, as the weights often vary considerably, according to the place of purchase of the pig-iron.

In the case of scrap iron this method is impossible, and estimating by inspection is liable to lead to serious discrepancies, especially in the case of large scrap in bulk, for the heaps may contain big spaces unless the scrap has been specially packed, which is unlikely. If there is a large stock on hand an error of several hundred tons may easily be made.

The up-to-date manufacturer is not content to wait until the end of the year to know how he stands; he wishes to know at frequent intervals—often monthly—and for this purpose it becomes necessary to know the quantity and value of metal stocks on hand. The information is required when buying orders are being placed. It is also necessary in order to keep a check on the wastage in melting and for the purpose of ascertaining that all metal purchased is duly accounted for. In the case of large castings, when the whole of a cupola charge is run off into one mould it is sometimes possible to trace definite quantities of metal in the different qualities, direct to a casting, but in the case of smaller castings this is not feasible.

The ideal method of ascertaining the weight of pig-iron, scrap iron and ore used is to weigh each bogie or truck load, as it is loaded ready for use at the cupola; and for this purpose an automatic self-recording weighing machine should be installed, either at the loading point or at the cupola mouth, each bogie load being run over the machine platform. The scrap must be loaded separately from the pig-iron unless two weighings are made of each bogie, one of the pig-iron and another when the scrap has been added, but this complicates the weighing records, and for that reason is not recommended. The daily weights are totalled from the machine records and the figures summarised weekly. In practice this method is open to several important objections. The weighing machines are liable to get out of order, as sand and loam penetrate into the mechanism, and also the records of the different qualities of metal may be mixed in the process of weighing.

The weighing of each bogie causes a slight delay which may lead to complications with the metal breakers and loaders, who are usually paid on the tonnage of metal melted.

A method which is not open to these objections and which will, in most cases, give the results desired, is to weigh the metal for current use in bulk and to rearrange and subdivide the stocks on hand. It is assumed that the information desired is as follows:—(1) The monthly consumption in the different qualities; (2) The stock on hand at the end of each month.

In order to obtain this information, the stock of metal in each quality should be divided into:—(1) Reserve stock. (2) Stock for current use.

The reserve or emergency stock should be stored in a convenient part of the foundry yard within reasonable distance of the cupolas, and the stock for current use should be placed as near the cupolas as possible, in order to save haulage. Arrangements should be made to divide the stock for current use into two—or if sufficient space is available into three—sections, one for the first month's supply and the other for the second month's supply. To commence the system a quantity of metal which it is estimated will be sufficient to supply the requirements for two or three weeks should be transferred from the general stock to the first month's supply, the metal so transferred being weighed in bulk in trucks and the weight recorded.

As fresh supplies are delivered at the works, each lot should be added to the first, second, or third month's supply, according as it is thought the metal will be required for use. Thus if the contracts on hand show that 500 tons of metal will be required for melting in the first month, 800 the second month, and 700 the third month, having transferred the necessary quantities from the general stock to the first month's supply to commence the system, any deliveries during that month should be added until the total, including the amount transferred, reaches 500 tons. Any further deliveries during that month should be put down for the second month's supply up to 800 tons, the balance of deliveries, if any, being put down for the third month's supply.

The deliveries will be weighed on receipt in the usual way, and the weights and details recorded under the supervision of the yard foreman, who will hand the particulars on to the office with a note specifying where each lot had been deposited.

Once the system is commenced this separation into lots will entail no extra weighing or handling,

and when the metal is required for melting it will be broken and loaded into bogies on the spot in the usual way. If any stock remains over from a month's supply, the quantity will usually be small, and the weight can be estimated, and the metal used as part of the next month's supply, a record of the same being handed into the office. If the supply for a month is found to be insufficient, then a quantity can be transferred from the next month's supply, or additional deliveries arriving near the mouth-end be put down. Under ordinary circumstances these transfers of stock will not amount to much, as the foundry output can be gauged from the record of contracts on hand for completion during the period. "Fettlings" and defective castings broken up and remelted need not be recorded in these figures so long as the remelting takes place during the current month.

By this means the counting-house will obtain an accurate record of all metal of different qualities loaded into the cupolas during each month, and this record can be used for the following purposes :—

(1) To check the consumption of metal with the output of castings.

(2) To ascertain the percentage of waste in melting.

(3) To prevent leakage.

(4) To ascertain the actual stocks on hand at the end of each month.

Checking Consumption with Output and Ascertaining Percentage of Waste.—This can be done by comparing the total weight of metal melted with the total tonnage cast, as shown by the Tonnage Production Book, care being taken that all castings on hand are weighed up and recorded in the Production Book on the last day of each month. The shortage in weight represents the waste in melting.

Leakage.—If there is any shortage, then the matter must be investigated and steps taken to prevent a recurrence. If fettlings or defective castings during the month have not been remelted the weights must be taken into account and carried forward to the month in which such metal is used.

Ascertaining Stock on Hand.—The purchases during the month will be recorded in the Purchase Journal and charged in a special book to the proper month's supply in accordance with the yard foreman's records. Transfers will be recorded in the same way, and the balance shown on the record of the current month's supply will give details of the metal melted. The actual weights of metal in the second and third month's supplies will be shown in the same book, and an account of the reserve stock should also be kept therein.

A monthly account can then be constructed as follows :—

	Scrap Metal.	Pig-iron. No. 3 G.M.B.	Pig-iron. No. 4 G.M.B.	Ore.
Debit—	Tons.	Tons.	Tons.	Tons.
To stock at annual stock-taking date, say Dec. 31st ...	1,000	100	50	100
To purchases in January ...	500	200	100	—
	1,500	300	150	100
Credit—				
By Metal melted during January ...	200	150	60	20
By Stock—				
February supply ...	250	50	40	—
March supply ...	—	—	—	—
Balance being Reserve Stock ...	990	100	50	80
	1,500	300	150	100

The office records for the three months' of supplies will appear as follows :—

	Scrap Metal.	Pig-iron. No. 3 G.M.B.	Pig-iron. No. 4 G.M.B.	Ore.
January Supply—	Tons.	Tons.	Tons.	Tons.
Purchases ...	250	150	60	—
Transfer from Reserve Stock ...	10	—	—	20
Balance metal melted ...	260	150	60	20
February Supply—				
Purchases, January ...	250	50	40	—
,, February ...	180	200	—	—
	430	250	40	—
Transfer to March supply ...	20	—	—	—
Balance metal melted ...	410	250	40	—
March Supply—				
Purchases, February ...	300	100	—	—
Transfer from February supply ..	20	—	—	—
Purchases, March ...	—	—	—	—
Reserve stock—				
Balance 1st January ...	1,000	100	50	100
Transfer to January supply ...	10	—	—	20
Balance January 31st ...	990	100	50	80

January production figures.

	Tons.	Tons.
Total weight of metal melted ...	490	—
Castings produced as per foundry production book...	—	400
Defective casting to be remelted in February ..	—	80
Balance waste ...	—	10
	490	490

Waste—10 tons on 490 tons melted = 2.04 per cent.

The figures obtained from these accounts should be inserted in the monthly budget prepared for use of the management. It will be a simple matter to prepare monthly cost accounts showing the gross profit on the output by adding the amount paid out for wages to the cost of the metal melted and other cupola charges, and deducting the total of these figures from the sale value of the castings made, thus :—

Sales for month as per day book ...			£ —
Deduct cost of metal melted ...	£ —		
,, wages	£ —		
,, moulding materials... ...	£ —		
,, coke used	£ —		
,, other cupola materials ...	£ —		£ —
Balance, gross profit			£

When castings are made for stock or for foundry use the system can be modified in order to bring these into account. The weights of coke used should be recorded monthly, and the quantity of coke used per ton of metal melted recorded in order to prevent waste and to check the melting power of the coke brought from time to time. The method here described will, if put into practice with such modifications as may be found necessary to meet local conditions, give information of considerable value to the management and lead to economical working. The stock figures will prove useful at the year-end, and accurate information will be available for balance-sheet purposes. The monthly budget mentioned will, if properly drawn up, contain a review of all the transactions (in totals) for the month as well as an approximate statement as to the financial position of the business each month-end.

Segregation Phenomena in Steel Castings.*

By S. S. Knight.

In steel which has undergone work the observation of segregation phenomena could not possibly give as satisfactory results as in ingots or castings which have had no work done upon them, because the soaking, rolling, or hammering all tend more or less to counteract the effect of segregation, both mechanically and chemically. The steel which is cast in sand moulds has long been looked upon as more or less of an uncertainty for the purpose for which it is intended, unless very large factors of safety are allowed, because it is almost impossible to get castings which are homogeneous. This lack of homogeneity comes about primarily from the occlusion of certain gases or foreign substances, such as dirt or slag, in the material itself while in a semi-molten or plastic condition, as well as from segregation.

Basic Open-Hearth Practice.

The "killing" of steel, as it is popularly termed, is unquestionably one of the hardest things to accomplish satisfactorily in the steel foundry. If basic practice is being used the fact that you have covering the molten metal in the ladle a slag which is hungry for all acid forming elements, means that it is beyond human possibility, as far as is now known, to keep your steel during pouring of the same chemical composition. The writer has seen many basic heats, running from 50 to 100 tons, poured from a single ladle, where the silicon content varied 400 to 500 per cent. in samples taken from the first and the last of the pouring, and yet the total amount of time consumed in the operation was less than half an hour. In some casting plants the metal is tapped into a receiving ladle mounted upon trunnions, and the basic slag skimmed and thus largely disposed of before being poured into the crane ladle from which it is teemed into the moulds. This partly obviates the difficulties encountered from the basic slag, but tends to cool off the metal in the ladle. The Talbot process or any of its analogues, which does all of the refining in the basic furnace and then allows the molten surface to be transferred to the acid furnace, to be there held so that the majority of the gases may escape from the bath before having the additions made, is probably the best approach to perfect practice which the open-hearth industry will be able to develop, as applicable to large quantities of metal. Even this, while not as expensive as the after treatment in an electric furnace, as is now being done in some four or five plants in the United States, is still too costly for the ordinary purchaser of steel castings. The reducing atmosphere of the electric furnace, as well as the tremendous agitation of the bath caused by the passing of current through it, in all of the resistance types, necessarily tends to produce a steel of great purity if the additions are properly made.

Acid Open-Hearth Practice.

In the acid practice the absolute inability to lower the sulphur and phosphorus content necessitates the use of high-grade material for which, of course, manufacturers have to pay a premium. On the other hand, acid steel, if properly made, should leave the furnace hearth almost free from absorbed gases, and before the pouring commences should be thoroughly killed and capable of producing castings free from blowholes which would arise from the composition of the steel itself. Probably a great deal of the trouble producers of steel castings have who use the acid process is due to the fact that the additions made in the furnace or ladle are not of the right composition, or are not properly made, and such expedients as aluminium shot for use in the heads and gates are of very little value. There should be no call for their use, since when the necessity for them arises it simply means that the practice in some previous operation has been lamentably bad.

The Converter.

Now in Bessemer practice the steel is poured at a much higher temperature, and as a result piping is aggravated and shrink holes and check cracks are more likely to occur. The additions, however, are very much more apt to be taken up by the mass of metal and thoroughly disseminated through it, owing to the fact that the temperature of the bath is higher and that the material has been in such a state of tremendous agitation. The heavy losses experienced, however, by the ordinary manufacturer making castings by the Bessemer process are such that the majority of the people who attempt to do this commercially are usually disappointed in the results which they get in a financial way. The low cost of installation and the facility with which this method adapts itself to intermittent production make it seem very desirable to the uninitiated; but as a general thing experience seems to be telling producers of steel castings that Bessemer plants are operated to the best advantage when they are maintained as auxiliaries to large open-hearth establishments, where work of the most desirable character for this process can be furnished them.

Crucible Steel Castings.

In the crucible steel industry the possibility of steel being properly killed is probably less than in any of the processes above described. Unfortunatey, the best result with this process, when graphite or black-lead crucibles are used, cannot be as good as that of the acid, Bessemer, or open-hearth processes described, owing to the fact that if the steel is held in the crucibles after the additions are made a sufficient length of time for the bath to be properly killed, the life of the crucible is so reduced that production becomes very expensive.

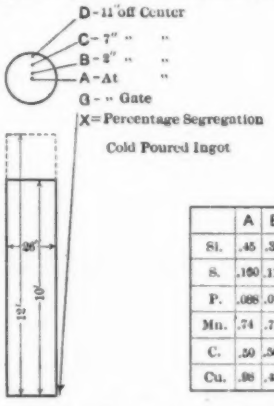
Probably of all the steel cast in America to-day crucible steel, as it is made and sold in the shape of castings upon the open market, is by far the least homogeneous.

Now leaving out of consideration all causes of the lack of homogeneity other than segregation we find that five elements are most vitally concerned in this phenomenon; sulphur, phosphorus, manganese, carbon, and copper, and all are subject to great segregation in bodies of steel when cooling.

*Abstract of a Paper read at the meeting of the Philadelphia Foundryman's Association, March 2, 1910.

Segregation.

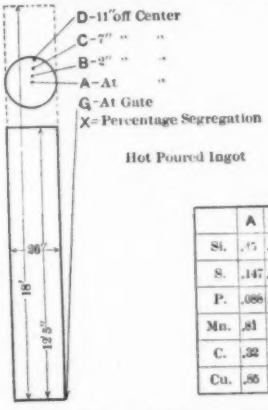
Fig. 1 shows an ingot weighing approximately 22,000 lbs., and serves well to illustrate several points not heretofore very clearly explained. This ingot was drilled at the gate G, where the metal practically set as soon as the pouring operation was completed, and where no chance for segregation occurred; it was also drilled at the points A, B, C, and D, these places being located at the centre, and 2, 7, and 11 in. off centre respectively. The transverse plane from which



	A	B	C	D	G	X
Si.	.45	.35	.35	.34	.34	32½
S.	.160	.110	.071	.051	.052	208%
P.	.088	.074	.032	.021	.020	340%
Mn.	.74	.71	.66	.66	.61	21½
C.	.50	.50	.27	.21	.21	138%
Cu.	.98	.48	.38	.24	.47	108%

FIG. 1.—SEGREGATION IN COLD POURED INGOT.

these drillings were taken was at the extreme upper part of the solid portion of this ingot, the piping taking up all of the part beyond this and the head. Other than this piping there was no evidence of lack of mechanical homogeneity in this material. The ingot was poured on end and in the ladle was added all of the steel plate, amounting to about 12 per cent. of the total weight of the bath, which the molten metal would take up, this plate being added at the



	A	B	C	D	G	X
Si.	.47	.42	.46	.36	.34	32½
S.	.147	.100	.038	.047	.052	183%
P.	.088	.057	.040	.032	.030	193%
Mn.	.81	.83	.76	.72	.61	49½
C.	.32	.46	.32	.22	.21	148%
Cu.	.85	.75	.46	.25	.27	215%

FIG. 2.—SEGREGATION IN HOT POURED INGOT.

time the metal was tapped from the furnace. In making these ingots no effort was made in any way to retard or diminish the shrinkage of the steel or the segregation of the elements mentioned. The piped portion of this ingot amounted to 17¾ per cent. of its total weight.

Fig. 2 represents another ingot made in the same way, but which was poured just as hot as it was possible to get the material in an acid furnace. It will be noted that the piping extends in the case of the cold poured ingot in Fig. 1 through just 16⅔ per cent. of its total length; in the hot poured ingot it extends through 30½ per cent. of its total length. The piped portion of the latter ingot was 27½ per cent. of its total weight. Inasmuch as both of these were cast in absolutely dry moulds this seems to show conclusively that the colder the metal can be poured into any casting the less piping and shrinkage there will be when the metal sets. Now, by looking at the analyses of the drillings which came from this hot poured ingot, the location of each sample corresponding to that indicated above for the cold poured ingot, it will at once be noticed that the hotter the material is at the time the casting is poured the less the tendency to segregation. For instance, in these two ingots the tendency to segregate was identically the same as far as the silicon was concerned, or 32½ per cent. In the cold poured ingot the segregation in sulphur amounted to over 208 per cent., in phosphorus to 340 per cent., in manganese to 21½ per cent., in carbon to 138 per cent., and in copper to 108 per cent. In the hot poured ingot the segregation in sulphur amounted to 183 per cent., in phosphorus to 193 per cent., in manganese to 49¼ per cent., in carbon to 148 per cent., and in copper to 215 per cent. By comparing these figures it seems reasonably certain that as far as the silicon and carbon are concerned the segregation is not much affected by the temperature at which the metal is poured. The sulphur and phosphorus would seem to segregate much more in metal which is poured cold than in metal poured at a higher temperature, while the tendency to segregation in manganese is directly the opposite. In copper, however, it would seem that the metal poured hot shows a far greater segregation than the metal poured cold.

Deductions.

In the first place, the slow and gradual cooling which is supposed to prevent segregation does so with only certain elements; at least, this is the deduction which would necessarily follow from the figures given above. In the next place the keeping of a perfect heat condition in the fluid or semi-fluid metal would probably tend to eliminate a large proportion of the segregated impurities, provided the temperature of the upper part could be so regulated that the extreme upper surface was the last to cool or set; in other words, that the cooling would take place, starting at the bottom and slowly rising to the top and in a regular manner. How this is to be accomplished we certainly cannot form any idea. It would seem in any ordinary casting that probably the greatest cause for segregation would be the throwing of the impurities toward the centre as the material sets. In the ordinary casting the probability is that in a very large percentage of cases the whole casting sets at almost the same time, and consequently the material is fairly homogeneous from a mechanical standpoint. Of course, large die blocks, forging ingots and pieces of such nature would be exceptions to this rule.

By looking at the analyses of the drillings taken from the several points it will be noticed that sulphur, phosphorus, and copper show the greatest tendency toward segregation. In the case of sulphur the writer is almost positive that all of this element which occurs in steel is in the form of iron sulphide of the chemical composition FeS. In cast iron he believes that a portion of the sulphur is in the form of FeS_2, and this is true with all forms of iron in which the amount of graphite or free carbon exists to any appreciable extent. This assumption is based upon the fact that in order to get the maximum amount of sulphur by the evolution method out of pig-iron or cast iron it is necessary to roast the sample. Now, this roasting is

of no avail in the ordinary carbon steels, as far as the writer knows, and he has never been able to get higher results by the use of this method on that class of material.

Segregation of the Different Elements.

In cast iron the writer was never able to isolate the sulphides metallographically. It is further his belief that in all steels the sulphur tends to segregate, and these segregations are one of the most fruitful causes of failure known to the steel industry. It would consequently seem a very wise provision on the part of the American Society for Testing Materials in limiting the sulphur content to a maximum of 0.050 per cent.

In regard to the segregation of phosphorus in iron the writer is of the opinion that there exists in all carbon steels the possibility of the occurrence of three distinct and separate phosphorus compounds. The first of these was shown in a very high phosphorus steel, the analysis showing 0.170 per cent. sulphur and 11.08 per cent. phosphorus. This material has no carbon, manganese, silicon, or copper in it. The peculiar crystals seemed to be monoclinic, and their arrangement was characteristic of this compound of phosphorus and iron. From experiments the writer has made he believes that the formula for this phosphide is represented by the symbol Fe_2P_2. The crystals were very soft, and they crumbled readily and broke in almost any direction. Practically all of them showed signs of cleavage transversely, such cleaving planes usually being separated four or five times the diameter of the crystals. This peculiar style of arrangement tends more to structural weakness than probably any other which could be shown. Another phosphide of iron was shown from a lower phosphorus steel, where there was no carbon, silicon, or manganese present. The sulphur was 0.128 per cent. and the phosphorus was 9.600 per cent. The crystals were fairly hard and did not easily crush. The writer believes this material to have formula FeP, although some of his experiments led him to believe that the phosphorus content would be sometimes much less than that shown by the above formula.

Manganese seems to possess the power to combine with sulphur at the high temperature of molten steel, or anything above 1,200 degrees C., and to form a very light slag which is immediately thrown to the surface. Instances are on record of material with as high as 400 per cent. sulphur losing 75 per cent. of its sulphur content at once upon the addition of 2 per cent. of high-grade ferro-manganese stirred into the mixture in the form of a powder.

In regard to the silicon content in iron and steel, so far the writer has been unable to isolate, either metallographically or chemically, any silicon iron compound. Its small percentage of segregation naturally leads us to believe that if the solid solution theory could be applied anywhere it would be more applicable to silicon than to any of the other elements.

The investigation of the segregation of the metalloids in carbon steels is certainly one of the most fruitful fields of research open to-day in the metallurgical world. The investigation of such phenomena as fatigue will also bring forth results of the most practical nature. From what work the writer has done individually he is led to believe, on account of the inability of any one to isolate the compounds of phosphorus, sulphur, silicon, and copper, when these elements exist in percentages of less than those specified by the American Society for Testing Materials, that it seems only probable that perhaps something similar to what is known as solid solution may occur under these circumstances. However, this would be very hard to prove, inasmuch as it would be almost impossible to find these compounds even if they did exist in steels which contained them in small quantities. The carbon iron compounds are already thoroughly isolated metallographically, and a good deal is known about them chemically.

In conclusion, too much stress cannot be laid upon the importance of a thorough investigation of this subject by a number of independent workers, so that the results obtained may be properly tabulated and inferences drawn, which will be much more comprehensive and correct than are now possible, owing to the small amount of information available at the present time.

FIG. 1.—VIEW OF OPEN-HEARTH FURNACE & FOUNDRY; MESSRS. JAMES LUMB & SONS, LIMITED.

A Yorkshire Steel Foundry.

At the works of Messrs. James Lumb & Sons, Limited, Elland, there is a somewhat interesting steel foundry—illustrated in the annexed photographic views—the furnace in which is of the Siemens open-hearth type, having a melting capacity of 6 tons. It has three charging doors, and two pairs of reversible air and gas regenerators. The lining is of the acid type, and it is a frequent occurrence for as many as three casts a day to be taken from the furnace. The heating agent is gas, generated from a gas producer by Messrs. Smith, Wincott & Company, of Glasgow. The gas is also utilised for heating an annealing furnace, capable of holding castings of gear wheels up to 15 ft. diameter, and also for heating a 9-ton and 5-ton ladle. These ladles have swan-necked stoppers for pouring the metal into the different moulds, and they are handled by a 15-ton travelling crane, which travels the full length of the foundry. The steel made in the furnace is used for

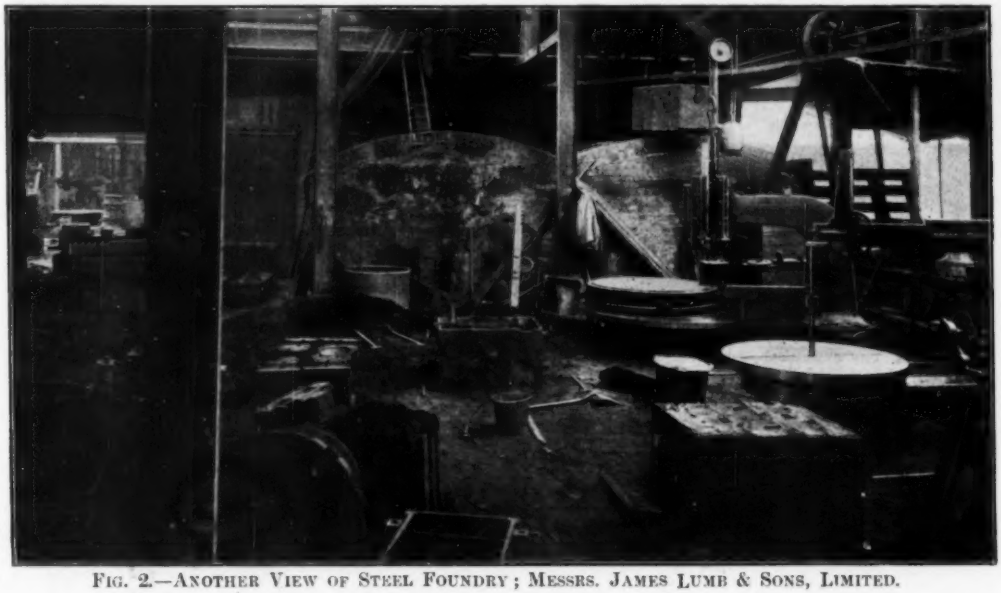


FIG. 2.—ANOTHER VIEW OF STEEL FOUNDRY; MESSRS. JAMES LUMB & SONS, LIMITED.

different castings, such as boiler mountings, hydraulic cylinders, and various types of gearing.

In the foundry there are four gear-wheel moulding machines, capable of moulding either spur, bevelled, double-helical, or skew gear, from 3 in. to 15 ft. diameter. The works' plant includes also a very well-equipped fitting and turning shop, for the finishing of all kinds of castings. The whole plant is driven by a 150-h.p. Corliss-valved engine.

Plaster-of-Paris in the Pattern Shop.

On the subject of the use of plaster of Paris for patternwork, Mr. E. I. Chase, writing in "Castings." says, "Many patternmakers do not use plaster where it would be of special advantage, as on experimental and hurry-up jobs where the main object is to get a few castings very quickly. It is so much easier, quicker, and surer in making a corebox, especially one consisting mostly of round sections, to turn up the core-stick, brad it to a board which has the layout on, and after placing it in an open-top box, to pour the plaster and so get the box complete, unless there are loose pieces to be afterwards added. Just contemplate the difference between this method and laying the job out on wood; often we must make right and left halves, and then gouge it out to templets."

But where this plaster method is especially advantageous is in making experimental castings for very crooked work, such as intake and exhaust pipes for automobiles. For ordinary corebox work in plaster the writer recommends making a layout on a board which has been planed true and has one edge trued up for gauging and squaring from, the core-sticks being then fastened on with brads and the necessary fillets and corners made with wax. The board and core-sticks then should be given a light coat of melted tallow with a fine soft brush. Make the enclosing box with gouge cuts in the sides to prevent the plaster from slipping out when the corebox is rapped (more often it is pounded) by the coremaker. All is now ready for the pouring of the plaster. When mixing the plaster, take the proper quantity of water—this is something that must be guessed at, according to the cubical contents of enclosing box—and stir the plaster in, being careful to avoid lumps. Mix quickly, and pour with it about the consistency of thick cream. This plaster should set in from 20 to 30 minutes. Some patternmakers use salt, borax, silicate of soda, and other chemicals to quicken or harden the setting, but the writer thinks these are of doubtful advantage. If the plaster is poured quite thin, it takes longer to set, but is much harder than if poured very thick. Also, when pouring quite thin there is not the liability of air bubbles remaining next to the work. As soon as it is poured, the box should be lightly rapped to jar loose these air bubbles and cause them to rise. The proper time to rap and draw off the bottom board and core-stick is when the plaster feels quite warm to the hand. Then it is expanded, and will loosen from the core-stick more easily than if left till it grows colder, as then it will contract and pinch on to the core-stick.

A Spark Arrester for Cupolas.

The spark arrester shown in the accompanying illustrations is applicable to single, double, or multiple cupolas. The principle upon which the invention is based is the controlling of the direction of the sparks and gases, the sparks being compelled to pass by the gas outlet on the top of the arrester, while the gases issue therefrom. This is effected by the use of a baffle plate at the side of the gas outlet, the sparks being sent down the unworked or idle cupola in cases where an arrester is fitted to two or more cupolas, and down a chute or other receptacle where the arrester is fitted to a single cupola.

The efficiency of this arrester, which is manufactured by Messrs. Samuel Osborn & Company, Limited, Sheffield, who hold the patent, depends upon the fact that it is so designed that the baffle plate in the arch is removed from the cutting action of the flame, and does not suffer in any way. In high-pressure cupolas where the heat is very great, this is a very important feature. The arrester requires no attention, as it is lined with brickwork and does not become deformed by reason of the heat. It is self-cleaning, and no water-cooling whatsoever is required. In one instance where arresters of the drum type were fitted to cupolas, but were giving constant trouble due to the baffle on the top getting destroyed through the heat, the double arrester described herewith was fitted to the two cupolas with quite satisfactory results, the amount of sparks collected down the unworked cupola amounting to nearly a cart load per week. The cupolas referred to were working at a high pressure, about 1¼ lbs. per square inch.

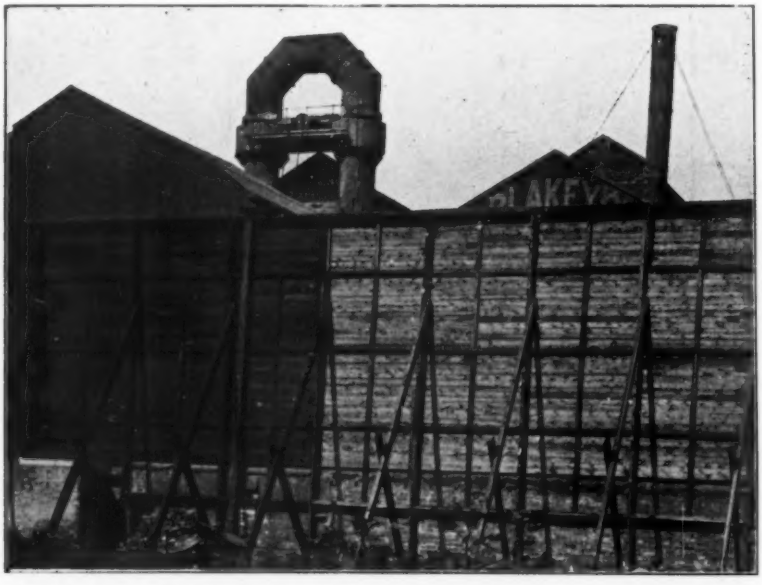


FIG. 1.—SHOWING OSBORN'S SPARK ARRESTER FITTED TO TWO CUPOLAS.

Fig. 1 shows the arrester fitted to two cupolas, the drum portion of the old arresters being shown still in position. The diagrams, Figs. 2, 3, and 4, show respectively Osborn's arrester fitted to one, two, and three cupolas.

Overhead Tramrails in the Foundry.

By A. W. MOYER

Planning an efficient and economical method of transportation of the many commodities used in a foundry is a question which is receiving more and more careful consideration each year. The most efficient method thus far brought to the attention of foundrymen is a well planned and well installed system of overhead tramrail. We will start at the rail itself. A standard section steel I beam in good straight long lengths makes the best possible rail. The section is sufficiently strong for the hangers to be placed as far apart as twenty feet and for a ton load to be carried. This form of rail cleans itself of the foundry dust, and permits the use of trolley wheels of large diameter. At the joints the rails are secured by heavy splice plates on the top and one on the bottom. The joints are close fitting. The trolley passes them with no jar or jump.

The method of supporting the rails is of importance as the rail must be hung from the roof timbers or trusses. Steel forged hangers are either bolted or lag-screwed to the trusses if of wood, or clamped if of steel, at the rail. The most efficient method of attaching to the hangers is by means of a properly designed clamp. These clamps are steel forgings so arranged that they clamp the top flange of the I beam rail. It should be borne in mind that the cost of any tramrail system to the foundryman depends on not only the price the manufacturer charges for his system, but the cost of the erecting must be added. It has been found that clamp hangers cost less to erect than any other style built, in that there is presented the opportunity of both a horizontal as well as a vertical adjustment.

The trolley should have cast iron wheels, forged steel yokes, set on a forged bedplate, with a steel

Abstract from a paper presented before the Philadelphia Foundrymen's Association.

forged eye. The trolley swivels so as to easily turn curves of as small a radius as thirty inches, though a curve of four feet radius is the standard and is used whenever possible. The wheels have turned crown threads and rotate on turned steel axles set in roller bearings in a steel sleeve. These trolleys for a ton load require but a thirty pound pull to operate. No oil in the bearings should be used on account of the foundry dust, but the bearings should be packed with Albany grease.

Switches are made to connect with two or three rails. They are provided with safety stops which effectively close all ends of the rails and are operated by pendant handles. The only parts of the switch made of cast iron are the hand wheel and bearing wheels; the rest are of steel forgings.

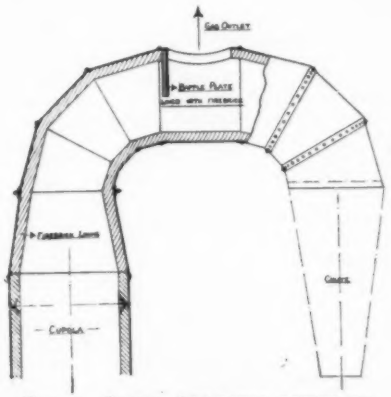


FIG. 2.—SPARK ARRESTER FITTED TO ONE CUPOLA.

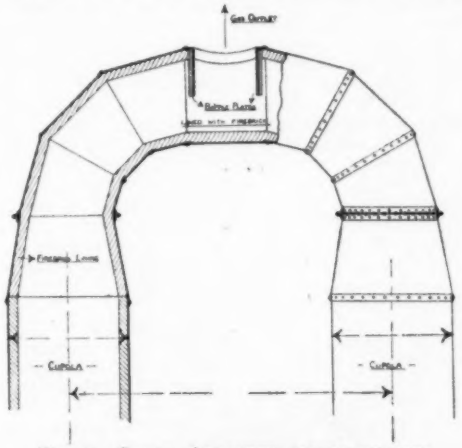


FIG. 3.—SPARK ARRESTER FITTED TO TWO CUPOLAS.

Switches that have cast iron guards and hinges are to be avoided on account of the liability of breakage and consequent accident.

It sometimes becomes necessary for two rails to cross at right angles. In such as case a "cross-over" is used. A pull on the hand chain throws one hinged tongue up. A pull on the other hand chain throws the other hinged piece down and the crossing is effected. Suitable guards working automatically are provided and effectually close all open rails.

Turn-tables, connecting two, three or four rails, are a necessity in some installations. On this machine two heavy cast bearing plates are used. The lower one is bolted down to the top flanges of the I-beam rail. The upper plate revolves on steel roller bearings. All open ends of the rails are guarded by steel forged angle guards which operate automatically. For foundry use these switches, turn-tables and cross-overs must be operated quickly, and must be absolutely safe. These machines are designed and built in a way which, for want of a better word, may be termed "fool proof."

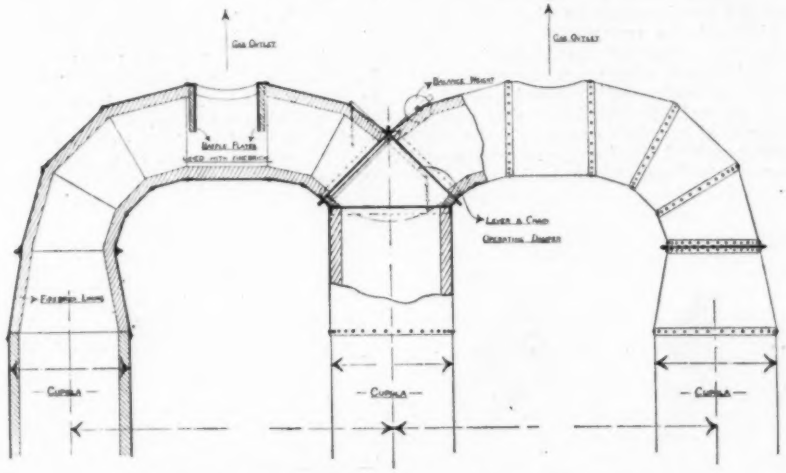


FIG. 4.—SPARK ARRESTER FITTED TO THREE CUPOLAS.

The foregoing may be taken as a brief description of the separate parts of a complete system. We come now to the proper layout for the average foundry. A line of rail should extend down through the yard where pig, coke, and scrap are stored, and this line run on to the elevator where a short section

of the rail is fastened to the elevator head, and a loop run around in front of the cupola door on the charging platform. By means of this lay-out loads of pig, coke, and scrap may be carried on the tramrail from the yard onto the elevator and off onto the charging platform. Coke can be charged from a skip travelling on the rail. It should be remembered that from 250 to 500 pounds of coke, 500 to 1,000 pounds of scrap, and up to a ton of pig is carried by *one* man from the yard to the charging platform and dumped into the door of the cupola.

Too much attention cannot be given to the proper lay-out of the rails in front of the cupola so that the hot metal may be moved as quickly as possible without interruption. In some plants a single rail may be used, but in this case a full load cannot pass an empty coming toward the cupola, and the spout must be plugged after each ladle is filled. Different arrangements for cupola lay-outs are made to fit the local conditions. A single cupola with tilting spout may be fitted with a switch arrangement whereby the empty ladles approach the spout on the outside rails and when filled leave the spout on the straight or inside rails.

The question is often asked as to what is the proper height to place a tramrail from the ground. Many different heights have been tried at various plants and with varying degrees of efficiency. It has been found that a distance of eight feet from the ground to the underside of the rail will enable a man to push a load of one ton with the least effort. In one case the rail was placed at a height of sixteen feet, contrary to the advice of the manufacturer of the system, but it was found that two men were necessary to convey the ton loads.

To save as much original cost as possible in the purchase of a tramrail system, the customer should do his own erecting. Many systems are sold at a considerable distance from the manufacturer's plant, and to do away with the railroad fare and high expenses of an erector it is necessary that the system be designed on simple lines, and that each piece be marked or numbered, and an erecting plan furnished with the consignment to show the position of each piece of the system.

We now come to a use for the tramrail which saves a considerable sum of money. It is that of handling cores. A section of tramrail should be made to extend down in front of the core storage racks and by means of a switch connect to the main rail running the length of the foundry. On the rail is a rack hung on trolleys. These racks are filled in the core-room and then run out over the main system to the floors. Springs are placed between the trolleys and the racks so as to take up any possible jar. The most delicate cores are handled in this way without breakage. After the rack is filled it is shoved out to the floors, and the required quantity of cores distributed in turn to each moulder.

A considerable saving may be effected by running a spur of the tramrail out to the sand bins so that one man can bring in a bucket load of one thousand pounds of sand. Running this over the main system he can shovel out the necessary quantity of sand to the moulders as he passes along, or he can dump the whole load when it is needed. Thus a thousand pounds of sand are carried as against the two or three hundred pounds of a wheel-barrow load.

The castings ready to be tumbled are loaded into dumping buckets, run into the rumbler room and dumped direct into the rumblers. A ton of castings may thus be carried, though it has been found to be best practice to have the dump buckets the same capacity of the rumbler, or half the capacity, so that it takes a certain number of bucket loads to fill a specified number of rumblers.

Probably one of the most important uses to which tramrails are put, is in the method of paying piece workers. Mistakes and disputes are entirely eliminated if the workman is paid by weight, which can be readily arrived at by a tramrail system which has installed at certain points tramrail scales. Let us assume that in the rumbling and grinding room a scale is placed, and when these two operations are finished the castings are weighed and the man who does the work is given a ticket with the weight and rate entered thereon. A duplicate of this ticket is turned into the time-keeper, who, after making the proper entry, passes it on to the cost-keeper. The scales conveniently record the exact weight of each operation. The scales are attached to a section of the rail which is so arranged that the load is weighed as it passes along. The necessity of lifting the load off the rail and onto a floor scale is entirely obviated.

The question of filling stock bins has been successfully answered by the tramrail. A balanced rack hung from a trolley will hold a number of easily handled boxes of uniform size loaded with castings ready to go to the bins. Care should be taken to arrange these boxes of a light enough capacity that a man can lift them off the balanced rack and dump the box-full into any desired bin.

In the making of soil-pipe many moulds are lost by reason of the metal in the small hand ladles not being uniform in temperature when poured. The better way is to pour from the tramrail, and when this is done an oblong ladle is used having four spouts so that the metal as it enters the pipe is of absolutely the same temperature. After the pipes are rumbled they are hung on a rack and a ton at a time shoved out to the oven, which they enter at one end and come out at the other. From the time the metal leaves the cupola until the finished pipes are ready for the stock bins or shipment they are carried on tramrails at an immense saving in labour.

There have been many arguments presented from time to time in favour of a flat rail tramrail. It may be said in favour of the flat rail that where hangers are short and suitable timbers can be found to which to fasten, a flat rail system is less expensive than an I-beam system. But it is necessary to have timbers every four feet, as there must for strength be a hanger every four feet, and this condition is so seldom met in a foundry as to practically throw a flat rail system out of consideration for foundry uses.

For the brass foundry the tramrail is a cost reducing appliance, well worth consideration. No method yet designed will take care of the carrying of molten metal quite as well as a tramrail.

As usually installed in a brass foundry using sunken furnaces, a section of the rail extends directly over the furnaces; on this rail a trolley runs, from which hangs a quick-acting chain block, an air or an electric hoist. For foundries where oil burning furnaces are used, the rail extends near the spout or mouth of the furnace and the metal is poured direct into the crucibles, while held in tilting tongs suspended from the rail.

After the crucibles are lifted from the sunken furnaces or poured from the oil furnace, as the case may be, they are moved along on the trolley to a point where the skimming process takes place. After being skimmed the crucible full of molten metal is run by one man direct to the moulding floors and the metal while still on the rail is poured in the flasks.

German Silver for Casting Purposes.

By A. Napier.

Quite a surprising number of names have been employed to designate the alloys of copper, nickel and zinc, and among the most familiar may be mentioned nickel silver, argentan, Virginia silver, and Nevada silver. A number of other titles used are merely trade names for the white metal alloys; in most cases they do not indicate at all the composition of the alloys. The copper-nickel-zinc mixtures employed in commerce may usually be classed as German silvers, a title which is a very broad one, covering a large variety of mixtures of these and often other metals, the addition of nickel, however, being the outstanding feature.

Nickel, which was discovered by Cronstedt in 1751, has a specific gravity when cast of 7.8, water at 60 deg. F. being 1. The melting point of the metal is about 1,450 deg. C. (2,642 deg. F.). Commercial nickel is obtainable in five forms:—Shot nickel, grain nickel, button or disc nickel, cube nickel, and electrolytic or cathode nickel. Shot nickel, which is produced by melting the metal and pouring it into water, is the poorest grade on the market, on account of the carbon absorbed by it in the melting. Carbon is an undesirable element in nickel for making good German silver and similar alloys, as it renders the metal harder and less malleable, and hence causes it to crack in working. With German silvers that have to be only cast and not worked, however, this feature is not so important. Grain nickel occurs in small masses about the size of a pea, but quite irregular in shape, the colour being much darker than that of shot nickel. Grain nickel is made in the following manner. The oxide of nickel obtained by treating the ore is mixed with flour or some other similar carbonaceous material, made into a cake, compressed, dried and then broken into the small irregular pieces in which the grain nickel appears. These are then packed in crucibles and kept for a length of time at a heat a little below the actual melting point of nickel, which has the effect of fritting the metal together in the form of the grains of the previous mixture. Button nickel is made in the same way, the button being formed from the nickel oxide and flour mixture with a briquetting press. Cube nickel is produced in a similar manner, the mixture being made into cubes instead of the other forms mentioned. Although these three latter forms of nickel are reduced in the presence of carbonaceous matter, they contain less carbon than shot nickel which has been melted. This is accounted for by the fact that the amount of carbon used in making grain, button or cube nickel is so regulated that it is all consumed in reducing the oxide, only a very small amount remaining in the metal. So long as there is an excess of oxide, practically no carbon is absorbed by the metal, but on being remelted it will take up carbon from the fuel.

Electrolytic or cathode nickel is the purest variety and is produced by depositing nickel by means of electricity, the deposit being removed in sheets after it has attained sufficient thickness. This variety of nickel contains no carbon and is used for high grade German silver where purity and malleability are of utmost importance. Button or cube nickel is greatly favoured by German silver makers, and though not so good as the electrolytic variety for first-class work, is sufficiently pure and free from carbon to give good results in the majority of cases. Shot metal is not employed, or should not be employed, for the manufacture of good German silver.

The copper-nickel-zinc alloys consist of a single homogeneous solid solution, and may be regarded as brasses containing nickel in solution. In the alloys generally employed the nickel contents vary considerably. Nickel may be present in amounts ranging from about 5 per cent. to about 30 per cent., and zinc from 20 per cent. or less up to nearly 40 per cent. Where a very low percentage of nickel and a high percentage of zinc are used in the mixture the alloy is usually employed for poorer work, or for work which has to be plated. The amount of nickel for general purposes does not exceed 20 per cent., however, as the cost is somewhat high, though to obtain a good white colour 25 per cent. of nickel is necessary. For high-class goods which have to be electro-plated, this amount and over is sometimes used in order to obtain a good white base, but often the alloy is distinctly yellow where electro-plating is done. Zinc, while being cheaper than nickel, has also the effect of making the alloy whiter, and lowering the melting point. This enables it to cast easier, and to take more readily the sharpness and intricacies of the mould. But at the same time zinc hardens the metal and makes it more brittle, so where strength or ductility are required an excess of zinc is objectionable. About 30 per cent. zinc, with about 55 per cent. copper and 15 per cent. nickel gives a very malleable and white alloy, but when the zinc exceeds that amount more frequent annealing is necessary if the alloy is subjected to rolling.

Other metals besides those mentioned are sometimes included in German silver, such as aluminium, iron, cobalt, silver, tin and tungsten. The addition of about 3 per cent. of aluminium gives a stiff and strong alloy, which casts well and soundly. This alloy, however, will only bend slightly without breaking, but as it gives a sharp definition and a good white appearance to the castings it is suitable for a considerable variety of work. It also does not readily tarnish or corrode.

A useful and not expensive white metal containing aluminium is obtained from a mixture of copper 50 per cent., zinc 34.9 per cent., nickel 15 per cent., and aluminium 0.10 per cent. The mixture is best made by melting together 19 parts of zinc and 1 part of aluminium, and pouring this into small bars which can be broken up. The final mixture can be made with copper 50 per cent., zinc 33 per cent., nickel 15 per cent., and the Zn-Al alloy 2 per cent. The copper-nickel should be melted together first, the Zn-Al alloy then added, and finally the spelter.

In connection with the use of aluminium there occurs a very useful copper-nickel alloy which ranks as one of the few copper-nickel alloys that have met with approval for industrial purposes. There is a class of goods such as horse-bits, etc., that requires a harder metal than ordinary German-silver. A suitable mixture for such purposes is:—Copper 65.00 per cent., nickel 32.25 per cent., and aluminium 2.75 per cent. This gives a strong, hard casting of a good colour, as white as German-silver, with a high nickel content. The metal, however, is not brittle and will bend considerably before breaking. If a stiffer alloy is required the aluminium may be increased a trifle. This latter metal is added after the copper and nickel have been melted together under a good layer of charcoal. When the copper begins to melt it is advisable to add 2 lbs. of borax to 100 lbs. of the metal, the whole being

stirred as soon as the nickel melts; the mixture should then be poured into ingots and remelted for the castings. In addition to toughening the alloy, the aluminium has the effect of making the metal more fluid for pouring, and thus allows it to cast better. The castings, too, are very sound, and do not adhere to the sand but turn out clean and sharply defined.

Iron in small quantities is quite permissible in German-silver that has to be cast, from 1 to 2 per cent. hardening the alloy and making it somewhat whiter. Cobalt is sometimes found in the alloy, but tends to darken it. Silver does not appear to be a valuable addition to German-silver as regards its mechanical properties, though a small quantity has no bad effect. Tin, on the other hand, tends to make the alloy brittle, and gives it a bad colour. Tungsten, in amounts from 1 to 2 per cent., is added to German-silver to form Platinoid, which consists of 60 per cent. copper, 14 per cent. nickel, 24 per cent. zinc, and the amount of tungsten mentioned. This alloy has a low electrical conductivity and is used for electrical resistances.

There have been a considerable number of special German-silvers patented from time to time, containing amounts of other metals than copper, zinc and nickel, but few of them appear to have had much practical value. As in the case of brasses, a great variety of effects and properties can be got by combinations of the original metals, and apart from the addition of aluminium employed as a deoxidiser or a constituent, copper, nickel and zinc still comprise the component metals of the German -silvers in general use. These alloys may be cast in the same way as brass, though not always with as much ease, and practically the same precautions have to be observed as in melting and pouring brass mixtures to obtain good castings. It may be mentioned, however, that to allow the metal to soak in the fire, instead of melting up quickly and pouring, is to court trouble with blow-holes. Although the castings may look well on being turned out of the mould they will be probably full of blow-holes, and consequently very weak.

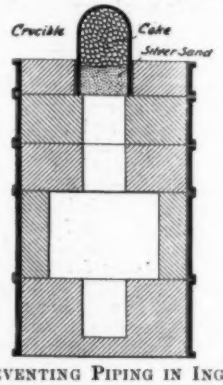
The forthcoming American Foundrymen's Convention.

Among the features of the Convention of the Allied Foundrymen's Association to be held at Detroit on June 6-10, will be a complimentary dinner given by the Detroit Committee to the officers of the Allied Associations and to the representatives of the technical Press, Monday evening, June 6, at the Pontchartrain Hotel; on June 7 a trip around the city given by the Ladies' Committee; a theatre party to the ladies in the evening, and a smoker at the Light Guard Armory. A boat ride on the Detroit River and Lake St. Clair is another of the entertainment features. The Plant Visitation Committee will give the delegates every opportuntity to visit the new foundries which latterly have made Detroit conspicuous in the industry, particularly foundries connected with automobile building. It is expected that the work of this Committee will be one of the best of the educational features of the coming Convention. Ten foundries are now under construction in Detroit, and three of them will be the largest of their kind in the country.

The Chairman of the Committee on Papers for the meeting of the American Brassfounders' Association, reports that several interesting contributions are already promised. Mr. W. M. Corse, secretary of the Brassfounders' Association, reports that the membership of his organisation has increased over 50 per cent. in the past year. The Detroit Committee, of which Mr. Frank T. F. Stephenson is chairman, has established headquarters at the Pontchartrain Hotel. The headquarters of the Foundry and Machinery Supply Association will be at the Cadillac Hotel. The two Foundrymen's Associations will have headquarters at the Hotel Pontchartrain, and the Associated Foundry Foremen will use the Griswold House as headquarters. The Detroit Committee has rented the Michigan State Fair Grounds, including all the exposition buildings, for the use of this Convention, and the exhibition of foundry equipment and supplies. These grounds are in the extreme northern section of Detroit.

Preventing Piping in Ingots.

The usual methods adopted with a view to preventing the formation of pipes during the casting of ingots are more or less satisfactory, but from a study of the theoretical problems involved, Von Parravicini has devised the following method, which has been proved at the works of the Hagener Gussstahlwerke. A crucible, with a capacity of about 60 cubic inches or more, is filled half full of finely crushed coke, the other half being filled with fine sand, preferably silver sand, and the whole kept as hot as possible in a heating furnace. In casting an ingot or chilled steel casting, the full crucible is inverted over the mould (see Fig.), just before, or immediately after, pouring is finished. By this means the surface of the molten metal is brought into contact with the highly heated inert sand, above which is the glowing coke. This combined column of sand and coke forms a kind of heat reservoir, which unites in itself all the functions required. For example, the sand prevents any carburisation of the metal by the coke, whilst the fact that the sand grains lie so closely together checks loss of heat from the steel. The heat generated by the combustion of the glowing coke replaces that lost by radiation, and supplies a further amount of heat to the metal. The previous heating of the contents of the crucible prevents the surface of the metal from cooling down too quickly on contact with the sand, as it would do if the latter were applied in a cold state, and finally the considerable weight of the sand and coke exerts a fairly heavy pressure in view of the liquid condition of the metal, thus facilitating the descent of the latter in the mould. It is stated that the method enables the height of the runners to be reduced by as much as 40 per cent., both in ingots and castings. —"Stahl und Eisen."



PREVENTING PIPING IN INGOTS.

The Equipment of the Grinding Department.

(*Continued from page* 203.)

Continuing the article on this subject commenced in our last issue, we herewith present illustrations and particulars of some further grinding appliances suitable for use in foundry and engineering plants.

A useful style of double-wheel tool grinder is shown in Fig. 10. The stand of the machine forms a tank from which water is forced upon the face of the wheels by a centrifugal pump, so as to preserve the temper of the tools while being ground. The driving is from an overhead countershaft, and the wheels are so protected as to allow of clean working.

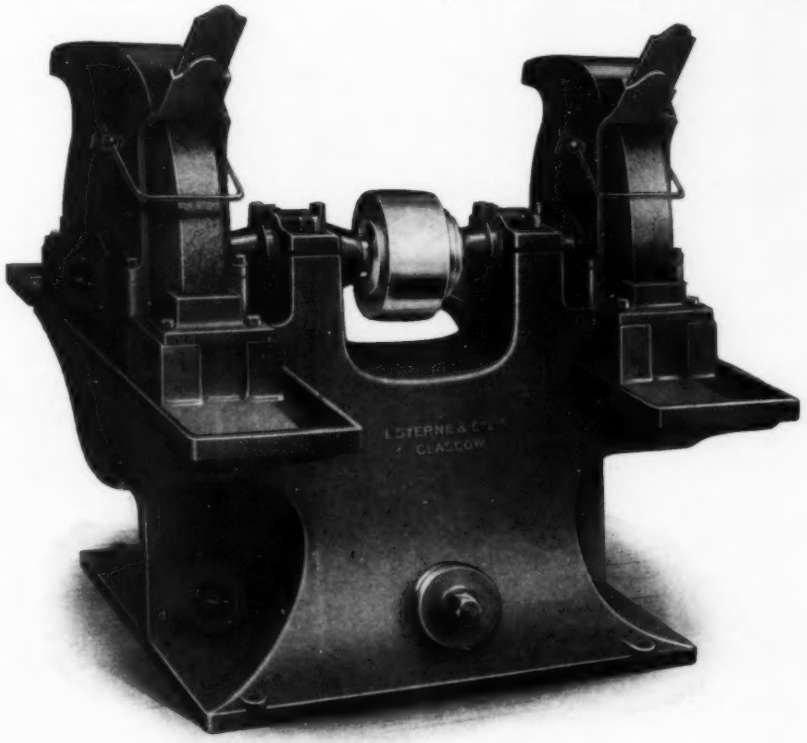


FIG. 10.—DOUBLE-WHEEL TOOL GRINDER.

The horizontal floor grinding machine, shown in Fig. 11, is one of Messrs. Rowland & Company's machines. The grinding wheel is mounted horizontally for surface grinding, on a massive cast-iron stand for attachment to the floor. The vertical driving spindle runs in gun-metal bushes, and the weight is taken by a hardened cast-steel toe-piece running in oil. The grinding wheel is preferably mounted upon a turned and balanced steel plate, the belt drive being horizontal, carried over flexible guide pulleys. The size of grinding wheels used on these machines range from 20 in. by 2½ in. to 36 in. by 3 in.

The machine depicted in Fig. 12 is constructed for grinding and polishing metal work by means of endless emery bands. Various breadths of bands, of various grits or coarseness, can be used, according to the work to be done, and work that cannot be performed on a grinding wheel can often be satisfactorily accomplished on these machines, such as the polishing and finishing of all kinds of brass fittings of irregular shape. They have, therefore, proved most valuable machines in brass-finishing establishments, and are also largely used by engineers for polishing iron and steel articles. The heads carrying the small pulleys are movable for adjusting the tension on the bands, and each machine has a tray or table for laying work on.

The 18-in. disc emery grinder, shown in Fig. 13, is by Messrs. C. Churchill & Company, Limited, Manchester. The standard and headstock are cast in one piece, a neat cupboard being formed in the base. The discs are 18-in. diameter, fitted with 8-in. back plates, and a patent anti-vibrating arrangement, which not only increases the efficiency of the grinder, but renders it practically noiseless under all conditions. The bearings are large and well lubricated. The boxes are of gun-metal, and ring oilers are provided, which supply an ample quantity of oil and distribute it from three points

in each bearing. The bearings are dust-proof, and suitable provision is made for drawing off the spent oil and refilling. The table on the left-hand side of the machine has vertical adjustment to nearly the

FIG. 11.—HORIZONTAL SURFACE GRINDER.

top of the grinding disc to allow of handling work having projecting parts. An adjustable swivel protractor, for guiding the work, is fitted to the top of the table. The table on the right-hand side is provided with a fixed guide at right angles, for use in squaring up the pieces being ground. Both tables are arranged to tilt for angular work, and are fitted with a stop for setting dead square when desired. They are both counterbalanced, and oscillate freely on the spindle which carries them.

The apparatus shown in Fig. 14, by Messrs. L. Sterne & Company, Limited, has been designed for grinding and cleaning the teeth of spur wheels. It is automatic in its action, the grinding wheel being carried by a sliding head which has an adjustable vertical traverse. The toothed wheel to be ground is centred on a stud and automatically moved round one tooth each time the grinding wheel reaches the bottom of its stroke. At this time the two wheels are quite clear of each other. Toothed wheels from 3 in. up to 30 in. diameter, from ¼ in. up to ¾ in. pitch, and up to 4 in. wide, can be accommodated on this machine.

The facing and shaping grinder shown in Fig. 15 is an important labour-saving appliance in fitting-shops, as a great variety of work can be shaped or faced up perfectly true with it. It is fitted at one end of the spindle with a cup-grinding wheel, 12 in. diameter by 6 in. deep by 1 in. rim, mounted in a steel shield, which allows the maximum amount of wear to be got from the wheel; at the other end of the spindle is fixed a disc grinding wheel, 12 in. diameter by 1½ in. thick. A rising and falling table carrying a compound slide rest is fitted to the cup wheel side of the machine, and the work to be ground is attached to the top slide by means of T-headed bolts in the slotted table. The cup wheel grinds on one side of the face only.

The machine shown in Fig. 16 is suitable for grinding metal to a flat surface. The work to be ground is fixed to the table, which travels automatically under the revolving grinding wheels, and can also be raised or lowered as required. The grinding wheels have an adjustable reciprocating motion over the work, thus ensuring a perfectly flat surface. These machines are made by Messrs. Sterne & Company, in sizes to take work up to 30 in. long by 8 in. by 8 in., and up to 42 in. long by 8 in. by 8 in.

(To be continued.)

Electric Steel Refining in the Arc Furnace.

The electric refining of steel was the subject of much discussion some two years ago, but so far has not made the rapid advances expected in England. Three furnaces, of considerable capacity, were erected in as many of the leading steel works in Sheffield, these being all of the induction type, mostly under the Frick patent. These furnaces have been shut down, though the Frick furnace is in operation at Krupp's works at Essen. That the induction furnace

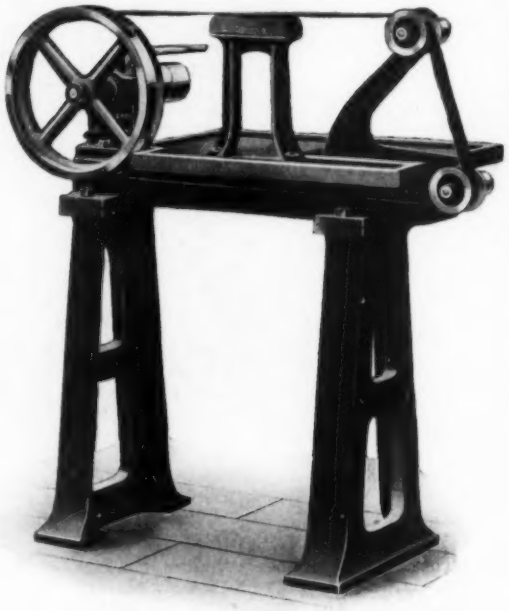


FIG. 12.—GRINDER AND POLISHER WITH ENDLESS EMERY BANDS.

was cheaper than the crucible process in wear to refractories and fuel consumption seems to have been established, and the failure seems to be due to difficulty of manipulation. In the induction furnaces good raw materials can be melted, but little refining takes place, and a serious difficulty in working it,

especially for alloy steels, is due to the advisability of keeping a molten bath in the furnace. The crucible steel-maker likes to start with an empty receptacle, and know what he puts in, but when estimating the metal left in a furnace by difference, that is, by weighing the metal teemed in the ladle, uncertainty and inaccuracy result. It is interesting, then, to note that both types of furnaces are being used in England, one Kjellin and three or four Héroult furnaces being now in course of erection in the leading steel works of Sheffield.

The advantages claimed for the arc system, which is entirely different from the induction type of furnace, are that cheap raw materials can be refined to a high state of purity by the heat of an arc, the design being similar to a small open-hearth furnace, which is easily tilted and controlled. There seems to be no doubt that steel of the highest analytical quality can be obtained from impure raw materials, and that the gases are most effectively removed in electric refining.

In Germany many furnaces of the arc type are in continuous operation, producing high-speed and ordinary tool steel, special steels for magnets and tubes, gun steel and shells, castings, and railway material, while in Austria, France, and America this method of steel refining has been extensively adopted.

In England it is probable that furnaces of the arc type will be adopted by several makers of tool steel, and a great improvement in the intermediate qualities results. Already two large manufacturers of railway material are making preparations for the adoption of this type of furnace, which will result in a radical re-adjustment of specifications, and will tend to improve all qualities of material and to obliterate any sharp distinction between crucible, Bessemer, and open-hearth steel, while it does not seem improbable that much of the imported Swedish material may eventually be replaced by domestic electrically-refined steel.

Since the development of the Héroult, Stassano, and Kjellin furnaces—this latter design having just been adopted by Messrs. Wm. Jessop & Sons, Limited—many types of electric furnaces, frequently involving complications and features objectionable to the practical steel maker, have from time to time been introduced, and extravagant claims have been made for their efficiency, but the adoption of the Héroult furnaces during the last few months by the United States Steel Corporation and the Deutscher Kaiser Works, which are the two largest producers of steel in the world, and by such representative British steel-makers as Messrs. Vickers, Sons & Maxim, Edgar Allen & Company, Limited, Thos. Firth & Sons, Limited—the former, after experimenting with induction furnaces, and the latter having operated the Héroult furnace for more than a year in associated Firth-Sterling Works in the United States—tends to prove that the complications of some of the newer types of electric furnace do not intimidate the active steel manufacturer. The adoption of the electric process by our leading steel-makers shows a confidence in the system, the justification of which is apparent to those who are in touch with foreign developments.

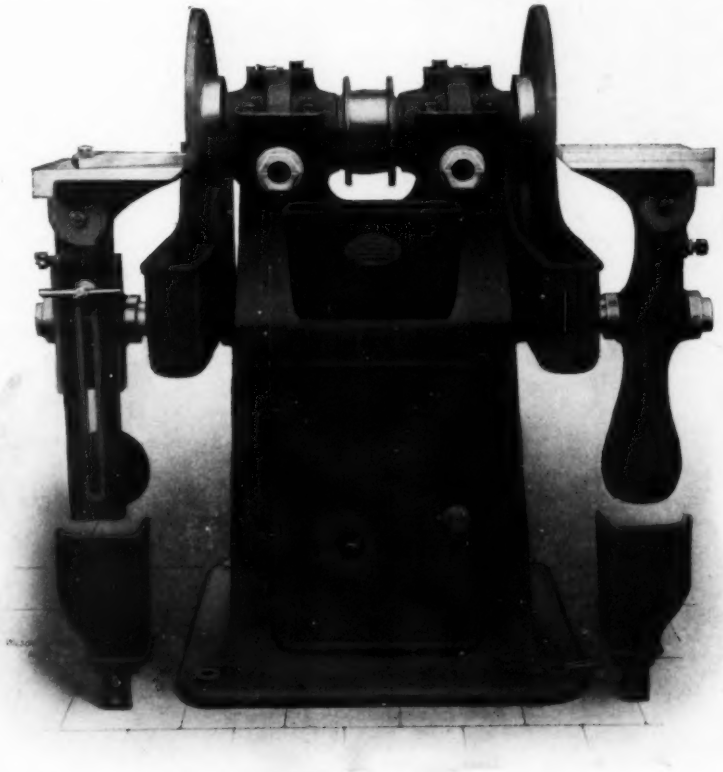


FIG. 13.—DOUBLE DISC EMERY GRINDER.

Birmingham Foundrymen visit the Watt Museum.

The Watt Museum at the works of Tangye's Ltd., is one of the most interesting historical collections of a great engineering district. It consists almost wholly of relics of the work of Matthew Boulton, James Watt, and William Murdock, all of whom by their ingenuity and inventive genius helped to build up Birmingham trade, and gave a great impetus to engineering progress throughout the world. The collection has attracted a good deal of attention lately, not only from its intrinsic merits, but because it is soon to find a place in the extension of the Birmingham Museum and Art Gallery. On Saturday, April 16, a visit was paid by the Birmingham Branch of the British Foundrymen's Association to the Museum at Cornwall Works, where they were met by Mr. R. J. Kirton, the curator, who spent about a couple of hours in explaining the various details of the rare treasures collected through the enthusiasm of Mr. George Tangye. Prior to visiting the room itself, an inspection was made of the pump department of Messrs. Tangye's, which was the scene lately of one of the most destructive fires that has ever taken place in this large establishment. Workmen were still busy clearing away the debris, and restoring the premises. The department is one of the largest connected with the works, and as showing the heavy output Mr. Kirton mentioned that if the building had been a dock stored with water, a comparison rather aptly suggested by its shape, the daily output of pumps simultaneously at work would have sufficed to clear out the water in ten minutes. Fortunately the fire occurred in a different part of the works than the Museum, but it has increased the anxiety of Mr. Tangye to remove the treasures to safer quarters.

The relics are stored in an oblong room in the north-east section of the building, and the various busts of the famous engineers, with those of George and Robert Stephenson, Sir William Fairbairn, John Penn, and others ranged about the room give the place a striking appearance. A very quaint survival is the leather luncheon basket in which for years Watt's dinner was daily sent down to the works from Heathfield. A chair is also shown, occupied many years ago by no less distinguished a person than the late Queen Victoria. Several of the exhibits had a special interest for the foundrymen, such as Watt's rotative engine, and sections showing different kinds of valve gear. Still more interesting was an old sectional model of a Newcome cylinder. It was this cylinder which gave a decisive turn to Watt's career, inasmuch as the task of repairing it set his thoughts in a new and exceptionally fruitful direction. Among examples of Boulton's ingenuity were a copying press and a most useful portable writing desk capable, by a simple folding arrangement with a movable metal support, of being utilised as a drawing board. The principal feature of the exhibit was the vast collection of mechanical drawings made by Watt and Boulton, which, it is said, are numerous enough to more than cover, if fully spread out, the entire walls of the great engineering establishment. Their careful preservation is shown by the perfectly freshness of colour, and their absolute clearness. Letters there are by

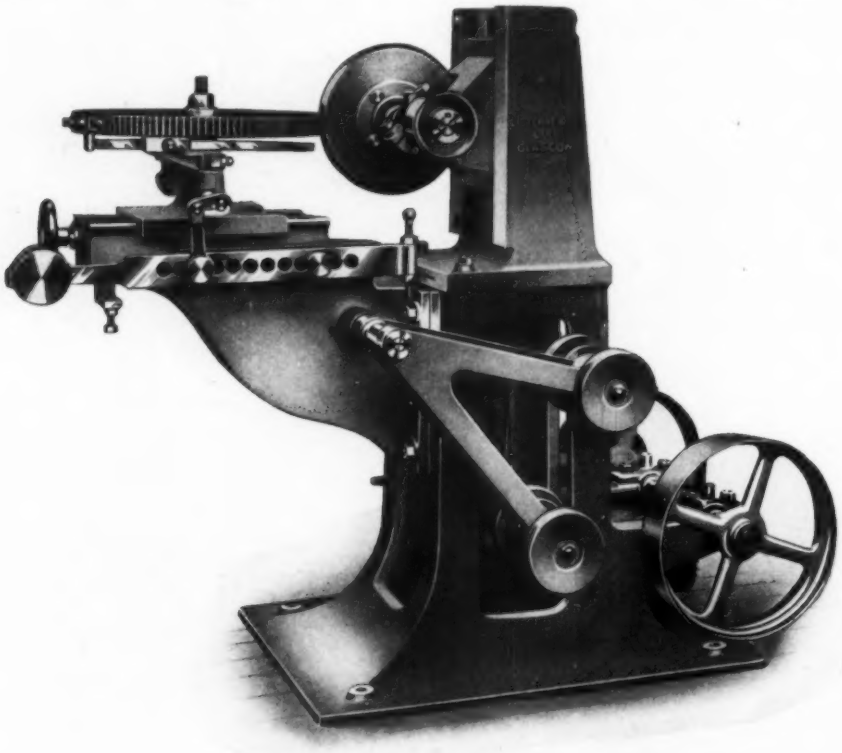


FIG. 14.—GRINDER FOR CLEANING TEETH OF SPUR WHEELS.

the thousand, and many of them are equally quaint and significant. The visitors were especially interested in the foundry wages book of 130 years ago, recording the wages paid to the staff. Apparently, they were not on a munificent scale. For example, in one week 30 foundrymen earned £27 0s. 5d., in another week 29 earned £23, and in a third week 30 earned £34 7s. 9d. The record, though not quite complete, shows that the rate of wages was a good deal below that now paid. A very suggestive exhibit is a collection of five flintlock guns with which the staff were once armed to repel an expected attack. Another curio is a piece of elm pipe cut from the centre of a tree which was actually employed underground in the East End of London before cast-iron pipes were introduced. Rare prints show the growth of the "Great Eastern" ship designed by Brunel. The literature is highly suggestive, particularly the advertisement for a recovery of a runaway apprentice, described as wearing "a dark brown waistcoat and blue pantaloons." Another very suggestive communication is a letter from a small shopkeeper in Cornwall complaining that two of Watt's employees had gone off in her debt, and appealing to the heads of the firm to pay the account, if they wished to avoid losing their workmen's services while in gaol for debt.

The collection is comprehensive enough to include engineering relics outside the Watt circle. For example a portfolio relative to Robert Fulton records his views respecting the proper speed of a locomotive as follows:—"As to six miles an hour, were it attempted and to succeed, I should consider it more a work of curiosity than utility, as I do not believe it possible to build a steamboat with any engine now known to run six miles an hour in still water and carry either passengers or cargo to pay the expenses."

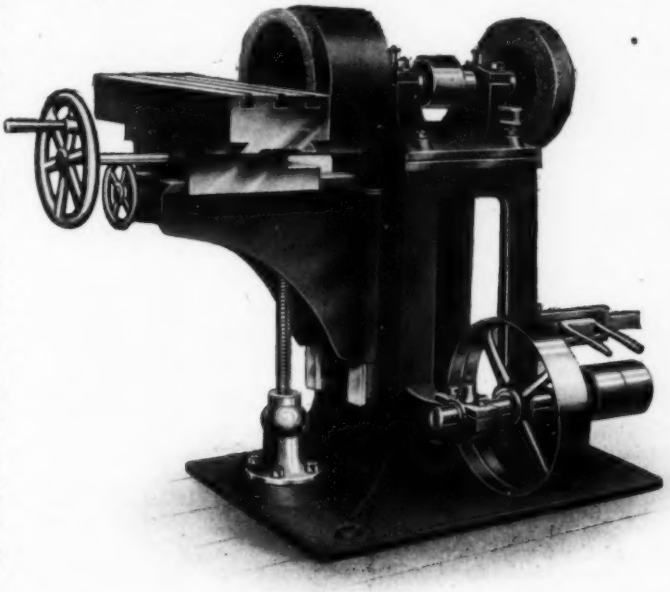


FIG. 15.—FACING AND SHAPING GRINDER.

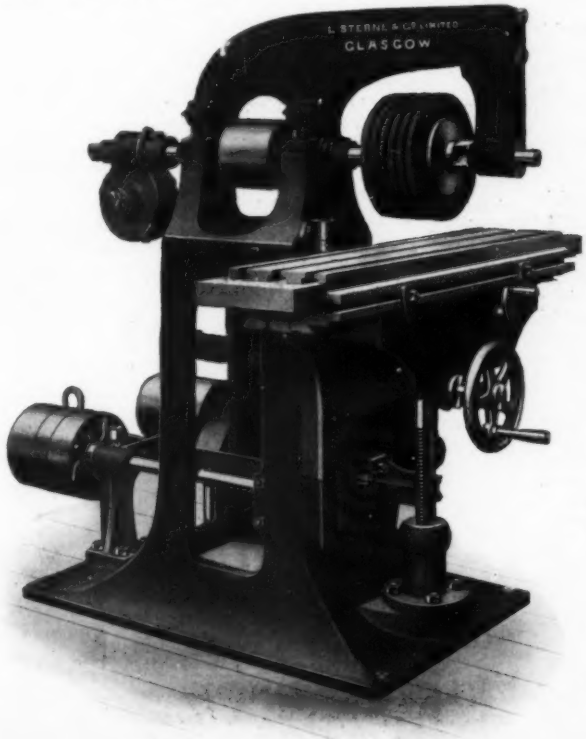


FIG. 16.—FLAT SURFACE GRINDER.

Equally interesting and suggestive is a photograph of Watt's famous workshop still existing in Heathfield Hall, the residence of Mr. George Tangye, where the tools, the old-fashioned foot lathe, and even the soiled apron hanging on the hook, still remain practically as they were left by the departed mechanic.

On the conclusion of the visit, a hearty vote of thanks was accorded Mr. Kirton for his painstaking information and his valuable help in making the inspection interesting and instructive.

THE Workington Iron and Steel Company, Limited, have determined upon the construction of a coast mineral railway line between Workington Dock and their Solway Iron Works at Maryport, a distance of five miles, and upon the erection of a bridge between Workington Harbour and the dock to couple up the line with their railway system at their Moss Bay Works, Derwent Works, and Harrington Harbour, two miles away.

Physical Properties of Foundry Coke.

A meeting of the Birmingham Branch of the British Foundrymens' Association was held at the Technical School, Birmingham, on Saturday, April 9, when Mr. R. Mason, the local President, presided over a large attendance.

The Chairman called attention to the competition and exhibition arranged by the Worshipful Company of Founders during the summer, and invited members to apply for information with a view to taking part in the competition. He then introduced Mr. R. H. Greaves to read a Paper on "Some Physical Properties of Foundry Coke," an abstract of which is as follows:—

If the question "What is foundry coke?" be asked, it seems that so great a variety of cokes have met with successful application in the foundry that a definite answer is impossible; but it is nevertheless possible to set up a sort of standard. There are certain general qualities which must be attained, both physical and chemical. Information with regard to the physical properties of coke destined for foundry use is often undervalued, though it is a matter of the greatest importance, and since this is the case, I wish to deal more fully with this aspect of the question than with the chemical aspect. Attention was drawn to the effect of the physical properties of coke by John Fulton, manager of the Cambra Ironworks Company, Johnston, Pa., in 1875, and his experiments were continued for several years. Dewey also published an investigation dealing chiefly with porosity, and a few years later the subject was taken up in Germany by Dr. Thörner.

Certain of the obvious physical properties enable us to form an opinion of the quality of the coke. For instance, it should be hard and compact, of a light iron-grey colour, with a silky or almost metallic lustre. The two properties with which I want to deal are hardness and porosity.

Hardness.

The coke must possess a certain hardness to withstand the descent through the furnace; this is far more important in the blast furnace than in the cupola, but cannot be neglected in the latter. It is a mistaken idea that the coke is crushed by the weight of the column of matter forming the charge. Thus, in a blast furnace 90 feet high, the pressure per square in. at the base is equal to a weight of 39 lbs., a weight very much less than coke of a very small resisting capacity would bear. The important factor is not the crushing stress, but the friability. As the coke descends with the charge, the pieces rub against one another, and against the materials of the charge, and in the case of a very friable coke particles are broken off, the gases are unable to penetrate, and the process is interrupted. Moreover, small particles may be carried off unburnt by the gases. The determining factor in the friability is the condition of the pore walls, which may be hard or soft. If the pore walls are of equal hardness and thickness, a porous coke will be more friable than a dense one, but the weakening effect of large pore spaces may be compensated by harder pore walls or walls of greater thickness between the pore spaces. The connection between porosity and hardness is by no means clear, but in general a greatly developed porous structure is associated with friability. The value of samples of coke from this point of view may be roughly determined by rubbing two pieces together, when, *caeteris paribus*, that which gives the smaller loss is the best.

The friability can also be gauged indirectly by measuring the hardness of the pore walls, *i.e.*, the resistance of the coke to compression. This is done by compressing a piece of coke of regular form in a compression testing machine. The usual form employed is a cube of 1 in., but the difficulty of obtaining accurate cubes of so brittle a material is very great, and moreover such cubes as are obtained are never free from slight cracks. Nevertheless, the results indicate the relative strength of different samples. If the coke is cut into cylinders of about 10 Mm. diameter, and surrounded by an iron jacket in which a piston works, the volume of the coke under increasing crushing stress may be observed. By working in this way, Dr. Thörner was able to show that as a rule the compressibility was directly dependent on the porosity both in the case of coke and charcoal.

Porosity.

By porosity is generally understood the percentage volume of the pore spaces in the coke. As a physical property of the coke it is most important, and its effect on the combustion and economy of fuel is somewhat complex. To determine the degree of porosity advisable in foundry coke, its resultant influence must be resolved into several different effects which are present together.

(1) In the case of the cupola, it has frequently been emphasised that the amount of fuel which must be employed is more a matter of volume than of weight. It is essential that the iron shall be held in the melting zone for a sufficient time to melt and heat it up to the required temperature. Since a porous coke occupies a larger space in proportion to its weight than a dense coke, it appears that by using as porous a coke as possible, a saving of fuel may be attained.

(2) In producing a high temperature it is necessary that combustion shall take place rapidly in order that heat may not be diffused away as rapidly as it is evolved. The rate of combustion of coke and charcoal is directly proportional to the porosity, since the more porous the coke, the larger will be the surface exposed to the air blast. This is well shown by the following figures, which were obtained by heating the different specimens of coke in a current of air for 10 minutes, 45 litres of air being used:—

Fuel.	Porosity.	Loss per cent. (corrected for loss of hydrocarbons on heating).
Compressed Coke	45.8	47.8
Coppée Coke	50·7	49.0
Oak Charcoal	56.4	65.4
Beech Charcoal	59 9	68.5
Pine Charcoal	76.7	82.1

In comparing coke in this way, the results are irregular on account of the varying hardness of the coke substance, which renders it more or less difficult to burn, and on account of hydrocarbons present. Hence, to ensure rapid combustion the coke should be as porous as possible.

Other considerations are opposed to this conclusion. As has been pointed out, the strength of the coke is in general diminished as the porosity increases. It must be remembered, however, that this is not necessarily the case, and in the cupola is not so important

a consideration as in the blast furnace. The effect of porosity on the rate of combustion has already been referred to, but still more important is its effect on the completeness of the combustion.

The Air Supply.

Mr. Mason and others, in discussion of papers, have frequently emphasised the fact that in the majority of cupolas too much air is blown in for economical heating. The effect of the excess of air is simply to diminish the temperature attained. The gases coming off from the top of a cupola should contain 11 to 15 per cent. of carbon dioxide, 0 to 3 per cent. carbon monoxide and as little oxygen as possible. An excess of 5 per cent. of oxygen deprives the furnace of as much heat as would be lost if the escaping gases contained 3 per cent. of carbon monoxide, besides decarburising the metal.

The use of the hot blast has been suggested for the cupola, but has never been successful. This is simply because the ratio of $\frac{CO}{CO_2}$ increases with the temperature, and so also does the rate at which the equilibrium is reached. There is, therefore, far greater danger of complete combustion with hot than with cold blast.

Determination of Porosity.

There are two important methods of determining porosity, but the better method is to determine the real and apparent specific gravity of the coke by separate experiments. The real specific gravity is that of the coke substance alone; the apparent, that of the coke substance and pores.

Real Specific Gravity.—About 3 grains of finely ground average sample of the coke (previously dried) are weighed out into a tarred specific gravity bottle of 50 grs. capacity, the sample is then covered with about 1 in. of water, and the bottle immersed in a beaker or dish of water at 90—100 degrees C. The neck of the bottle is attached by a tube to a water pump, and the water in the bottle is kept gently boiling for about two or three hours. The tube is then detached, the bottle, filled with water with the usual precautions, and weighed.

If m = mass of dry sample
m_1 = mass of bottle filled with water sample
m_2 = mass of bottle, sample, and water to fill;

$$\text{Then the real sp. gr.} = \frac{m}{m_1 - m_2}$$

Apparent Specific Gravity.—This may be taken by the aid of Anderson's volumenometer. A vessel with a capacity of from 25 to 100 c.c., is closed by a ground glass stopper, which is prolonged upward into a narrow tube to which a stopcock is fitted. The lower part of the receiver is connected by a piece of thick walled pressure tubing to a tube graduated in cubic centimetres. An ordinary burette may be used for this purpose. The receiver is first filled with water to the level of the stopcock, which is then closed, and a reading of the tube is taken. The stopcock is then opened so that the water flows into the tube, the stopper is removed, and a weighed quantity of dry coke is introduced into the receiver in fairly large pieces. The stopper is replaced and the water caused to return to the level of the stopcock, which is then closed. The instrument is briskly shaken, to detach adhering air bubbles, this air is allowed to escape, and a reading of the tube is taken. This gives the volume of the coke direct and the quotient, $\frac{\text{Mass}}{\text{vol.}}$ gives the apparent specific gravity.

$$\text{Porosity or percentage volume occupied by the pore} = \frac{(\text{Real sp. gr.} - \text{apparent sp. gr.}) \times 100}{\text{Real sp. gr.}}$$

For example, a sample of Elder's coke gave:

Real sp. gr.	1.98
Apparent sp. gr.	1.09

$$\text{Hence porosity} = \frac{0.89}{1.98} = 44.9\%$$

This sample was taken from the top of the oven, and is more porous than that taken from lower down. A variation of 5 to 10 per cent. is sometimes observed in samples taken from the upper and lower layers of an oven. It is an old rule that foundry coke should sink when thrown into water, and like others is probably founded on a good deal of experience. If the value of the density of the coke substance is assumed to be on the average 1.8, then a coke having a porosity of 40 per cent. would show an apparent specific gravity of 1.08, that is, it would just sink when thrown in water.

In the course of the lecture, experiments were shown illustrating the rapid oxidation of finely divided carbon, the effect of porous charcoal in accelerating chemical reactions, and the absorption of gases by porous charcoal. Apparatus for the determination of porosity were also shown.

Discussion.

Mr. Stacey Jones, in opening the discussion, said that he had had some experience in the testing of foundry coke. He found that most methods of determining the friability, hardness, and porosity of coke were really misleading, because what they wanted in regard to all those matters was to test the coke when it was red-hot at the temperature of the cupola. There was all the difference between its condition when hot and cold. He had his doubts whether cold tests had any value whatever. It would be a great advantage to have a reliable method of determining hardness at one thousand degrees Centigrade. At present they had no data whatever on that subject. He had made a few experiments with a certain measure of success, though they were far from being absolutely satisfactory. A difficulty arose through the oxidation of the coke during the experiments. His method was to take a small tube, fix it in a gas furnace filled with coke, and heat it up to about 1,000 degrees. A pyrometer could be used to indicate the proper heat. Then he got an iron rod at a similar temperature and pounded the coke with the red-hot pestle until it was a fairly uniform degree of fineness. When he had brought it down to the size of a seven or ten mesh sieve it was covered up quickly and allowed to cool. With regard to friability, he took a piece of coke, and pounded it in a mortar until it would pass through a ten-mesh sieve, and subsequently through 30 or 40 mesh sieves. By that means he ascertained the percentage of smallest particles. He had tested the smashing operation both upon hot and cold coke, and was astonished at the difference, because the hot coke was so much softer. They might say that the softness when it was hot was 70 per cent. to 75 per cent. greater than when it was cold, though it varied enormously with different cokes. The testing of hot coke, if a reliable method could be devised, would be a very important achievement for the ironfounder. The real thing they wanted to know was the behaviour of coke in the cupola, and what they wanted to know was not information as to the amount of porosity, but the relation and effect of porosity in cokes that were well known and commonly used. It was a mistake to restrict the experiments to coke in the barrow. He had known so many examples of materials behaving quite differently in the cupola. It seemed to him that

lectures would be more serviceable if a popular newspaper method were adopted. A style of lecture very suitable for a society of chemical industry was not applicable to a body of working foundrymen. It would be particularly useful to obtain and tabulate results arising from the use of various local cokes.

Mr. F. J. Cook agreed that there were a variety of practical questions still remaining to be thrashed out, although some had been solved. In regard to the generation of heat in the cupola, he would like to know the effect of blast pressure, and whether an increase contributed to efficiency. It would help them to know the effect of greater or less volume upon the rate of melting and on the coke consumption. Some standards would be very useful as to the proper volume of air per ton of iron melted. It had been said that a good foundry coke should sink. He entirely disagreed, his belief being that it should float with at least one-third of the coke exposed. He had made many such tests, and the best cokes always exposed one-third above the water. A good rough and ready method to test the pore space was to take two pieces of coke of the same size, and to see whether one would sink more than another, and also to see which would sink the more quickly. That would test the question of weight per volume, and the one which attained the highest position in the water would have the greater pore space. He had used that method many times, and always been pleased with the result. He had found cokes supposed to give good results and satisfying tests of hardness and even of chemical analysis which turned out badly in the cupola. It was a good thing the matter was being dealt with so methodically by the chemist, and though the results were not at present such as could be practically applied they must eventually tend to benefit the trade generally.

Mr. Walker said they had considerable difficulty owing to the variety and the character of different trucks, and it would be very helpful if they had tests which could be applied when a truck arrived at the foundry. It was embarrassing to have one or two trucks working well, and then find the next truck doing very badly indeed. It would be a great advantage if the man in charge of the furnace could form an approximate judgment as to the behaviour of his coke. It was not sufficient to be able by rubbing two cubes of coke together in the way suggested, although that would tell them which was the harder and which the softer. They wanted to know in advance the value of a truck, before they had found it out from unfortunate experience. There was no time in the present rush for the adoption of elaborate tests. Ready and practical methods were very much wanted, rendering unnecessary a series of chemical operations. Most foundrymen would benefit by knowing the practical value of various cokes.

Mr. George Hailstone thought possibly he could answer the last question, as he had had much experience in the use and analysis of coke. His own standard for good coke was that it should not contain above ¾ per cent. of sulphur nor more than seven or eight per cent. of moisture. Great variations in the latter respect were inevitable. They might have a truck load containing 30 per cent. of moisture, while on another occasion it might not be more than 1 per cent. When a truck arrived into the works they generally took away six or eight pieces for testing purposes. The pore space ought to be about 40 per cent. But that depended to some extent on the size of the pores. If the pore space was very large, the coke would sink in water. A coke with large pores was usually a weak coke. After taking their sample, the first thing to do was to see if it would float, and on that matter he agreed with Mr. Cook that a coke one-third above water was generally the best, and was certainly correct in pore space. If it differed from that they expected trouble. He had experimented for five years, dealing with thirty different cokes, and that was a safe test with regard to pore space. It was not possible to tell without analysis the amount of sulphur. Naturally, the coke makers did not want coke returned and would try to comply with requirements; he had only rejected two trucks of coke during the last two years.

The President said he had found the same difficulty as Mr. Walker owing to the changing of sources of supply. As soon as they had got use to a certain class of coke they found the buyer going somewhere else and upsetting the whole business. That was due to the determination by managers to economise. That led to a great waste of coke, and complaints from the manager. At the same time, it was better to use an excessive amount of coke than to spoil the casting. The real test was chemical analysis, although that was too troublesome for the foundry foreman. If the firm would adopt that they would find it would pay, and the analysis need not be continuous when the buyers were satisfied of the quality. He did not agree that a coke should have a silky grey look and a kind of metallic lustre. That metallic look had been lost through a new process, but he had found equally good and even better results with a dark coke than with a good-looking coke. The question of moisture was one of great importance. When he had got a complaint about the amount used he found that after deducting the moisture he was actually using a smaller instead of a larger amount than had formerly proved satisfactory. Coke was usually more friable when it was wet, and it was good to have it well shaken during its progress to the foundry. Wet coke was very wasteful, and a good deal of it was ground down by its transfer to the bins, and thence to the platforms. The crushing of coke by the weight of iron, especially on the top layer, was a serious matter, but he had known that obviated very successfully by a founder who spread flat pieces of scrap on the top of the coke, which prevented a good deal of the crushing. It was the prevention of that crushing which constituted the only advantage of hardness. Otherwise, a fairly soft coke was better, especially with the flat scrap spread over it. It was also very important to have thorough ventilation through the particles, and he was satisfied that some of the slow results were due to the excessively large lumps of coke used. A good standard was to have the coke somewhat bigger than an ordinary cricket ball. That gave them the proper exposure of surface to the air. He quite agreed that a certain amount of coke was necessary to raise the iron well above the tuyere. The fuel below the tuyere did not burn. Experiments had been made showing conclusively that iron below the tuyere never melted at all, and it was equally true that there was a certain height above the tuyeres at which the melting was most efficiently carried on. He had known instances where pieces of wood used to light fires had been brought out of the furnace from below the tuyeres and had been found not to have burnt at all, although the metal had been melting above for three hours. That proved conclusively the lack of heat in the lower part. At the same time, he thought a good deal too much was made of what was called the melting zone. By the melting zone, the same thing was not always meant; usually from 18 in. to 2 ft. above the tuyeres was implied. That might be the hottest part of the furnace, and yet not the melting zone, which he should put very much higher. He had seen iron break up and tumble into soft, spongy masses six feet above the tuyeres. Metal would melt at a much higher position than what was called the melting zone, but it got hotter as it descended.

MR. GREAVES, replying to the discussion, agreed that testing at a high temperature was extremely important, but a difficult thing to carry out. As to blast pressure, probably the volume of air necessary at high pressure would be slightly less than was wanted at a low pressure. The large pore spaces would have very little effect on chemical action. What was called the catalytic action depended rather upon smaller pores.

Stopping Off.

Among the many problems presented for solution in the foundry, those offered by the subject of this article are not the least interesting. A good moulder likes a job which has something about it, as he puts it, and one often comes across stopping-off jobs which have a good deal about them, both of hard work and thinking points. The following is a description of the methods which have been followed in stopping off gas engine beds to various depths. The standard proportions were as shown in Fig. 1, the size, of course, varying according to the engine required.

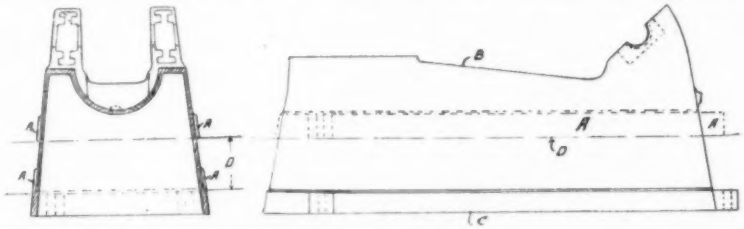


FIG. 1.—GAS ENGINE BED.

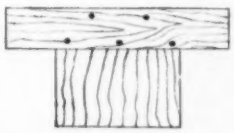


FIG. 3.—STRIKLE.

Occasionally beds were required which were shallower than the standard depth, the alterations varying from time to time, and no size other than standard being required with sufficient frequency to justify the making of a special pattern. Under these circumstances the usual practice was for the pattern-maker to fix onto the pattern fresh strengthening strips and holding down lugs, as at A, Fig. 1, both strips and lugs being fixed so that the edge D gave the proper depth of bed required. The pattern thus prepared was then sent into the foundry for the moulder to wrestle with.

joint at E was filled up or stopped off by holding a piece of board underneath and ramming down through the cope bars.

Owing to the amount of work involved this simple method was not feasible where half the depth or more of the bed was to be stopped off; in such cases another course equally simple was followed. A strikle, Fig. 3, was ordered, of sufficient depth to strike out the inside level with the top of the new strips outside. The interior of the pattern was first rammed up with core sand and suitable irons, and carefully strikled out to proper depths. The cores were then lifted out, packed up with sand on suitable plates and dried; or if they were too delicate for this method of handling, the rest of the pattern—after ramming up the cores to proper height—was filled up with sand, a plate clamped on, and the whole rolled over, the pattern drawn off, and the cores stoved. The pattern was bedded in the floor and a level joint made at the height the finished casting was required to be, the pattern drawn, and after straightening the joint, pieces of stiff paper were placed at the edge of the mould, as at G, Fig.

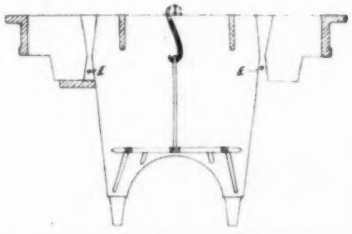


FIG. 2.—SHOWING METHOD OF MOULDING.

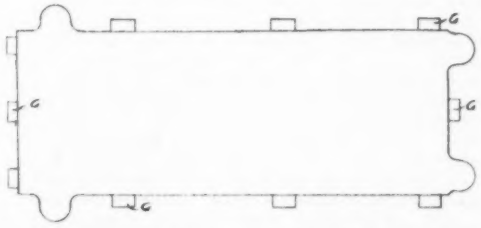


FIG. 4.—SHOWING PIECES OF PAPER ON EDGE OF MOULD.

Where not more than 6 inches was to be stopped off, the method of moulding was as indicated in Fig. 2. The mould was rammed up in the ordinary way to the top of the pattern, where a drop joint was made down to the top of the new strips and bosses. Sand was also built up to the side of the pattern to form a sloping joint and give a clean lift. The cope was then rammed up in the usual manner, lifted off and set on stands for finishing overhead, when the space left between the hanging core and the drop 4, with a drop of stiff clay wash on each. The cope (which had meanwhile been rammed up on a level bed) was now tried on and staked. On lifting off, the pieces of paper came with it and formed an excellent guide from which the outline of mould was laid out on the cope. Within this outline the previously mentioned cores were then set and fastened by hooks through the cope bars, after which the mould was finished, closed, weighted, and cast, in the ordinary way.

Crystallisation and the Effects of Various Elements on Cast Iron.*

It seems scarcely possible to exaggerate the importance in designing castings, of so arranging their outline as least to interfere with the natural laws of crystallisation, which come into play during the cooling of the metal.

Iron which has been poured into a mould, on changing from a liquid to a solid state becomes a mass of crystals. These crystals are more or less irregular, but the form toward which they tend and which they would assume if circumstances did not prevent, is that of a regular octahedron—an eight-sided figure which may be imagined to be formed out of two pyramids having their bases together. The crystals are too small to examine closely, but an idea of the form and arrangement of single crystals may be got by an examination of aggregations of crystals. These may be got by casting a solid block, and after the exterior has solidified, pouring the interior out, when a mass of crystals is formed. Crystals begin to form against a cooling surface and interlock with each other, holding between themselves minute flakes of graphite. That the free carbon is in irregular flakes is proved from the nature of graphite, and because flakes of graphite may be picked out of the casting.

In a perfect crystal of iron all the axes, that is, the lines joining the opposite angles, are of equal length and at right angles to each other, but very few crystals are perfect, for they are more or less tangled with or pressed out of shape by those next to them. The prevailing directions of crystalline arrangements may be made more clear. In a round bar the crystals all radiate from the centre, as in Fig. 1. In a square bar they are arranged perpendicularly to the four sides, and hence have four lines, in the diagonals of the square in which terminal planes of the crystals abut or interlock and about which the crystallisation is always confused and irregular, Figs. 2 and 3.

FIG. 1.

FIG. 2.

FIG. 3.

The direction of the crystalline radiation in Fig. 4 follows the planes of the figure with the exception of one deviation; in it are the same diagonal lines of weakness. The pairs of diagonals joining the corners nearest to each other are joined by a long line parallel to the two long surfaces; this line is also a line of weakness, since the lines in which the crystals assemble in the systems belonging to each surface, as the casting cools, elongate toward the centre, and when they meet in the middle they do not form continuous lines through from one surface to the other. It may here be remarked that in casting large thin plates such as flooring plates, it is the practice of the founder when they are cast open to cover them over with loose sand as soon as the metal ceases to be liquid and then to remove the sand so as to expose the surface of the metal to the action of the air in a crosswise direction, the object in doing so is the more rapidly to cool those portions where crystallisation is longest in taking place.

In a circular plate to which is attached a large portion of a cylinler, Fig. 4, it would be most difficult to get the centre portion to cool, and thereby crystallise in the same ratio as the outer edge, for the heat is so much concentrated in the centre that those portions of the mould cannot be removed until crystallisation has almost stopped. It is of great importance that the proportions of the metal should be arranged so as to neutralise those two divergencies and also to reduce the lines to a minimum. If a circular plate 9 ft. diameter, Fig. 5, be cast and cut

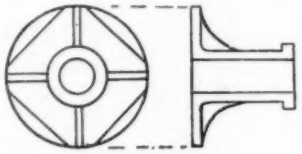


FIG. 4. FIG. 5.

from the centre, the contraction of the iron by crystallisation would give an opening of 1¼ in. The strain upon this plate must be very great and many such castings fly into pieces upon the least heat acting upon them. It is therefore necessary to rearrange its formation so as to reduce the crystallisation to a minimum. This can be done by changing the form from a circle to one of the shape shown in Fig. 6, taking off four sides and thus reducing the strain.

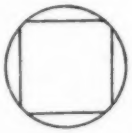


FIG. 6.

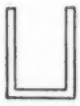


FIG. 7.

FIG. 8.

A cylinder of a hydraulic press was made in the following form with a square bottom (see Fig. 7). Under the severe water pressure to which it was exposed, fracture took place all round and along the plane of junction of crystals, which formed perpendicularly to the external and internal surfaces of the bottom end and of the sides of the cylinder. This proves that such planes of junction are planes of weakness, planes in which the cohesion of the metal is less than in any other part of the mass. A new cylinder was accordingly made with the bottom rounded instead of square (Fig. 8); this stood the strain upon it and remained uninjured. The natural remedy for such trouble is to avoid all sharp corners, allowing the metal, when possible, to flow in curved lines instead of sharp square corners.

Now, since regularity of development of the crystals in cast iron depends upon the regularity with which the melted mass cools, and the wave of heat is transmitted from the interior to its surface, arranging the crystals in the lines of least pressure in its transit, so the size of each crystal depends upon the length of time during which the process of crystalline arrangement goes on—that is to say, the length of time the casting takes to cool. The lower the temperature at which the fluid cast iron is poured into the mould, and the more rapidly the mass is cooled down to solidification, the closer will be the grain of

* Abstract of a paper presented before the Lancashire Branch of the British Foundrymen's Association, by T. W. Markland (Bolton).

the metal, the smaller the crystals, the fewer and less injurious the planes of weakness, and the greater the specific gravity of the casting. The very lowest temperature at which metal can be poured, so as to fill every cavity of the mould without the risk of defect, is that at which a large casting, such as a heavy anvil block, hydraulic cylinder foundation bed, or fly wheel segment, ought to be cast. It is here, however, that the difficulty of the founder begins, especially where castings of a complicated form are required. The aim should be to get every portion of the mould filled without cold shots or collections of impurities arising in the metal. It is thus an absolute necessity to have the metal as liquid as possible and to get the mould filled as rapidly as can be done.

Silicon in Cast Iron.

Metallic silicon is said to be of a dark iron-gray colour, and has such an affinity for oxygen that it must be kept from contact with the atmosphere. The specific gravity of silicon is 2.49. It alloys with iron in all proportions up to 10 per cent., and by special treatment up to 20 or 30 per cent. The presence of silicon is necessary in iron to be used for ordinary casting purposes. In 1885, Professor Turner in his researches found that additions of silicon to white iron would change it to gray, and by varying the silicon the softness and grayness could be controlled at will. This discovery was of such practical importance to founders that the question was raised whether the influence of silicon would be the same in ordinary pig-iron made in a blast-furnace. Professor Turner successfully made silicon-iron in a blast furnace.

The influence of silicon is indirect, acting through the carbon which the iron contains. Silicon lowers the saturation point of carbon, that is, an addition of silicon to iron containing combined carbon expels carbon in graphite form, which is caught between the grains of the Fe., giving it a grayer colour. The influence of silicon is modified by the various conditions attending remelting and cooling of the iron. The more total carbon in the iron, the less silicon will be required to produce a given effect. By changing silicon in an iron mixture we can control the state of carbon and also the chill. Silicon, acting through carbon, is therefore the controlling element in cast iron; it removes the chilling tendency of an iron. This influence is greatly modified by the state and quantity of carbon in the iron used.

Anything that decreases silicon increases shrinkage. Keep, in June, 1894, prepared the following proposition:—"To produce a given uniform grain and a sound casting and with $\frac{1}{8}$ in. shrinkage to the foot, the silicon must vary with each variation in the size of the casting, and such variation in silicon will cause a variation in the shrinkage of a $\frac{1}{2}$ in. test bar." The following table will indicate the correct amount of silicon for each size of casting to produce a shrinkage of $\frac{1}{8}$ in. per foot according to this proposition:—

Approximate Key for Regulating Foundry Mixtures.

Size of Casting.	Silicon required in the Casting.	Shrinkage of the Casting.	Shrinkage of a $\frac{1}{2}$ in. square test bar, from the same ladle.
Inch.	Per cent.	Inches.	Inches.
$\frac{1}{2}$ square.	3.25	.125 per foot.	.125 per foot.
1 ,,	2.75	.125 ,,	.135 ,,
2 ,,	2.25	.125 ,,	.145 ,,
3 ,,	1.75	.125 ,,	.155 ,,
4 ,,	1.25	.125 ,,	.165 ,,

Phosphorus.

Phosphorus from $\frac{1}{2}$ per cent. to 1 per cent. will do all that can be done in a beneficial way; all above that amount weakens the iron without corresponding benefit. No element of itself weakens cast iron as much as phosphorus, especially when present in large quantities. Phosphorus is neither a hardening nor softening agent, but if it is either, the tendency is on the side of hardening.

The fluidity of the metal is slightly increased by phosphorus, but not to any great extent. Generally speaking, to some extent phosphorus prolongs the period of fluidity of the iron while it is filling the mould. It is dissolved by the iron up to about 1.7 per cent., after which it separates in the free state. Carbon tends to throw phosphorus out of solution.

Sulphur.

The addition of sulphur diminishes the carbon and silicon. These reductions tend to make the iron white. It also tends to increase shrinkage. The rapid melting of pig-iron in a cupola cannot possibly add much sulphur.

Manganese.

Manganese combines with iron in almost any proportion; but if an iron containing manganese is remelted, more or less of the manganese will escape by volatilization, and by oxidation with other elements present in the iron, especially sulphur. The addition of ferro-manganese diminishes the silicon in cast iron, which causes the increase of chill. Cast iron, when free from manganese, cannot hold much more than 3.8 per cent. carbon, but as the manganese content increases, carbon also increases, until it is found in spiegeleisen as high as 5 per cent., and in ferro-manganese as high as 6 per cent.

Because commercial spiegeleisen and ferro-manganese are white, it seems to have been taken for granted that the combined state of carbon in irons high in manganese is caused by the manganese. Mr. Ward made a 16 per cent. spiegel perfectly gray, very tough and strong, but which could not be cut. The following is an even gray and a white iron:—

	Grey.		White.
G. C.	3.61	G. C.	nil.
C. C.	0.38	C. C.	3.70
Si.	1.47	Si.	0.30
Mn.	1.78	Mn.	0.65
P.	0.017	P.	0.017
S.	0 009	S.	0.011

This shows that manganese has nothing to do with the grayness or the chill.

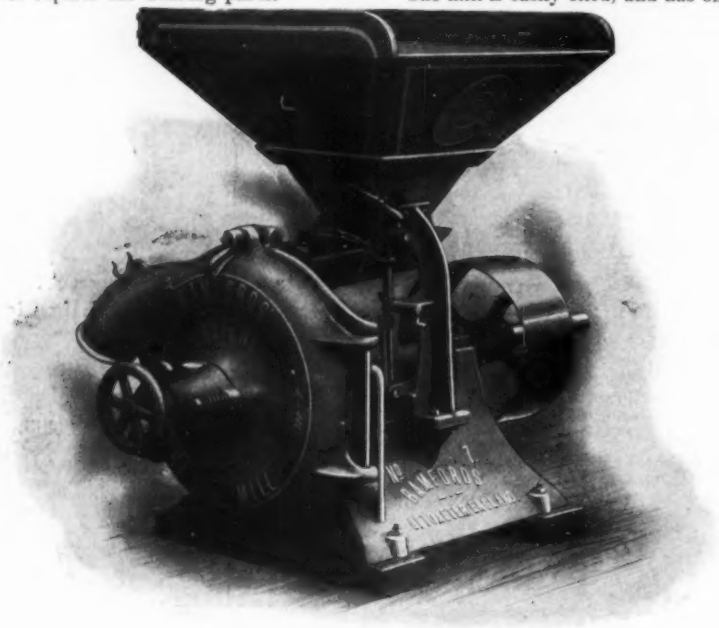
Manganese increases shrinkage; an increase of 1 per cent. manganese has raised the shrinkage 26 per cent. So long as any carbon remains in the combined form an increase of silicon will drive such carbon into graphite, and this in some degree decreases shrinkage. Adding ferromanganese to molten iron generally reduces strength. The small percentage of manganese in commercial foundry pig-irons will have little, if any, influence on strength. Much that is present in pig-iron may escape during remelting, and it may aid in removing sulphur which has been brought in with the fuel.

An increase of 1 per cent. of manganese has increased the hardness 40 per cent. If, however, a hard chill is required, manganese gives it by adding hardness to the whole casting. This hardness is probably due to the hardness of the manganese itself, and not because more of the carbon has taken the combined form. If soft castings with low shrinkage are required, manganese should be avoided.

Foundry Plant and Equipment.

Grinding Coal Dust.

Herewith illustrated is a grinding mill, which is well adapted for producing fine coal dust for use in foundry work. The construction of the mill is simple and strong, with all parts easily accessible, and are so arranged that an intelligent labourer can work the mill and reverse or replace the wearing parts.



GRINDING MILL FOR COAL DUST.

The grinding surfaces are two circular bevil discs, with cutting edges on each side. When these become worn each disc can be changed from one side to the other, and the mills then grind again equal to new. It is claimed that the discs are capable of doing a great amount of work before they require reversing, they being made by a special process which renders them so hard that no file will touch them. They are claimed to be superior to any description of chilled iron. To change or reverse the grinding plates is but the work of a few minutes, and as each plate is accurately machined and fits on a true surface it is impossible to put them on wrong or untrue.

The mill is easily oiled, and has only one strong steel shaft with two bearings, which, being in full view, cannot become clogged. The delivery spout is fixed on the side at a convenient height for filling sacks, no elevator being required. These mills are capable of grinding upwards of 2 tons of coal dust per day.

The makers are Messrs. Bamford & Sons, Uttoxeter, to whom we are indebted for the foregoing particulars.

The Osborn Jolt Moulding Machine.

In Figs. 1 and 2 is shown a plain jolt moulding machine made by the Osborn Manufacturing Company, Cleveland, Ohio. The particular feature of this machine is the variation of the length of stroke that may be obtained. This variable length of stroke is controlled by a travelling valve, which is adapted to be set to give any stroke required, from 3-16 to 1½ in. The ability to change to different lengths of stroke will be found of great advantage in foundries moulding a variety of castings, and where there is a variation of the air pressure. Another feature of the machine is the large diameter of cylinder used, which results in greater stability and a more accurate stroke. It is declared that each machine will be found to have a lifting capacity greatly in excess of its rating, and in spite of this greater lifting capacity, it is claimed, the machine requires a smaller quantity of air per lb. lifted than any other machine made. This result is attained by the use of an ingenious blocking device used in the air chamber, as shown in Fig. 2. This blocking system consists of a set of fixed rings (*a*, Fig. 2) which fill up a large portion of the space that would otherwise have to be filled with air.

Fig. 1 is a general view of the machine and Fig. 2 a sectional elevation, from which the construction and operation will be readily understood. The machine is operated on 60 lbs. air pressure, or less than that required for similar machines. With the system of blocking employed, cylinders of larger diameter may be used to give greater stability and to keep the table on centre when heavily loaded. At the same time less air is used even than in machines with smaller cylinders of the same lifting capacity.

To change the length of stroke to suit the work

or meet variations in air pressure, the travelling port valve *b* can be set to give any stroke from 3-16 to 1½ in. The height to which the mould is raised before it is allowed to fall is governed by adjusting the exhaust valve by the lock nuts *c*, shown under the table of the machine. The travelling port valve that permits the change of the stroke is the particularly novel feature. The table plunger works inside of the cylinder, and when the air is turned on the plunger is forced up until the table opens the exhaust and the sudden release of the pressure allows the plunger to drop and jolt, again closing the exhaust, and so on.

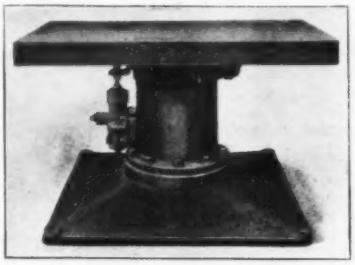


FIG. 1.—THE OSBORN PLAIN JOLT MACHINE.

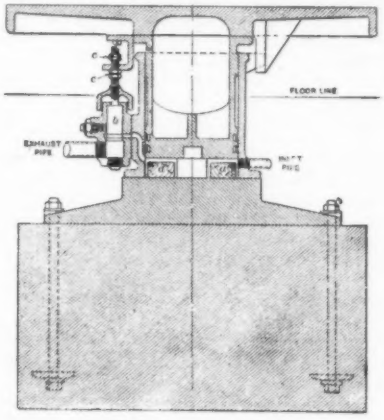


FIG. 2.—SHOWING CONSTRUCTION OF THE OSBORN MACHINE.

The machine is made in sizes to take moulds ranging in weight from 1,000 to 20,000 lbs. The smallest size has a table 33 in. by 33 in., and the largest a table 60 in. by 96 in. The machines with a lifting capacity of 15,000 to 20,000 lbs. have steel tables; the smaller sizes have cast-iron tables.

The cubic feet of air required per minute ranges, according to the size of the machine, from 48 to 295.

THAT a slight rupture has taken place in the working of the English and Scottish steel trades agreement, which has been in existence for some years is reported. William Beardmore & Company, Limited, Glasgow, have under a threat of withdrawing from the understanding demanded that its works and those of Vickers, Sons & Maxim, Limited, at Barrow, in which it is largely interested, shall be given a free hand with respect to interchange of material without charging the extra costs against the English concern. This is strongly opposed in Scotland, as it is held that it would place Vickers, Sons & Maxim in a specially favourable position in tendering for the existing naval work and probably lead to the work being diverted from the Clyde yard.

"Skull Cracker" Lifting Magnet.

At the new iron and steel plant now being installed at Gary, India, U.S.A., by the Indiana Steel Company, a subsidiary of the United States Steel Corporation, there has been introduced an appliance for the breaking up of scrap castings, etc., which constitutes an interesting development in the adaptation of the lifting magnet. The chief feature of the appliance, which is illustrated herewith, lies in its lifting power, a "skull cracker" ball weighing no less than 12,000 lbs. being raised to the desired height by the magnet and allowed to fall by the switching off of the current. It was supplied by the Electric Controller and Manufacturing Company, of Cleveland, Ohio, U.S.A. It is obvious that this method of handling "skull-cracker" balls presents important advantages over the old style of crane link with dis-

"SKULL CRACKER" LIFTING MAGNET, 12,000 LBS. CAPACITY.

engaging latch. The latter is usually tripped by pulling a rope which, quite as often as not, starts the ball swinging and so impairs the aim of its descent. Moreover, the man engaged in the act of pulling is always in a position of more or less danger, being liable to be hit by flying pieces of metal. Time and labour is also expended in moving by hand the pieces to be broken, and then the broken pieces. With the magnet method of lifting, however, the labour required is confined to the crane operator and one ground man. The magnet handles not only the ball, but the pieces to be broken and also the broken pieces. Since the ball is released by simply cutting off the current, no swinging occurs, and a true hit is ensured with every drop of the ball.

The "F.T.J." Bookshelf.

Metallography.

By Cecil H. Desch, D.Sc, etc. London: Longmans, Green & Company, 39, Paternoster Row.

It is a fitting testimony to the position which metallography holds amongst the sciences, to find this able work issued as one of the "Text-books of Physical Chemistry," edited by Sir William Ramsay. The author, who is the Graham Young lecturer in metallurgical chemistry in the University of Glasgow, where the whole of the photo-micrographs in the book have been prepared, has dealt with the subject in an excellent manner. Following the introduction, four chapters treat with the diagram of thermal equilibrium, after which are valuable chapters on practical pyrometery and thermal analysis, and the preparation of micro-sections. Under the title of "The microscopical examination of prepared sections" the practical points of the microscopic apparatus are dealt with. The crystallisation of metals and alloys is then fully explained and illustrated by micrographs and drawings. The author then proceeds to the more complex phases of his subject, and amongst others gives a very instructive chapter on electromotive force and corrosion. A consideration of the molecular condition of metals in alloys and the nature of inter-metallic compounds is, naturally, included in the treatise, while the explanations of the plastic deformation of metals are particularly graphic. The metallography of iron and steel is treated separately in one of the final chapters, the author regarding this course as desirable on account of the complexity of the relations exhibited by these metals. The non-ferrous industrial alloys are also briefly considered in a separate chapter, and the whole work is indexed for ready reference to any point, making altogether a very valuable addition to this series of text books.

Engineering Workshop Machines and Processes.

By F. Zur Nedden, translated and revised by John A. Davenport. London: Constable & Company, Limited.

This volume is offered as a hand-book for the use of students and others taking the workshop training recommended by the Institution of Civil Engineers, and contains as an appendix a report on the education and training of engineers adopted by the Council of that Institution. The German edition of this book was written to assist young engineers during the term of practical experience which forms part of their training, and as much of that volume is not applicable to the Englishman's training, only those parts which have a direct bearing on engineering education in this country have been included. While at first glance this may not appear to be a book of much interest to the foundryman, yet the foundry is so closely associated with the engineering shop that many workers in the former require to gain an intimate knowledge of the latter and its methods. Opening with general remarks on the efficiency of engines and machines, the author proceeds to discuss the effect of workmanship and design upon the efficiency. As an example of modern engineering works are given a description and plan showing the general arrangement of the works of Messrs. W. H. Allen, Sons & Company, Limited, Bedford, and following that, materials of construction are dealt with to some length, the various raw materials of engineering, their methods of manufacture, etc., being briefly outlined. In this chapter foundry pig-irons are dealt with, but the descriptions of the different classes of iron do not savor of any very intimate practical acquaintance with foundry pig-irons. The chapter on the foundry and pattern shop, too, will strike practical foundrymen as being rather bald, though it may serve as an introduction to the subject for the use of engineering students about to enter the shops. When dealing with the machine-shop proper the author appears more in his element for some really valuable hints and information are contained in this section of the book. Altogether there is much that is useful and valuable, despite the incompleteness which characterises some parts of the work.

Metallography Applied to Siderugic Products.

By Humbert Savoia; translated by R. G. Corbet. London: E. & F. N. Spon Limited, 57, Haymarket.

The application of metallography to iron and steel research work has reached such an important stage, thanks to the labours of Sorby, Martens, Osmond, and others, that this little volume will be very welcome in metallurgical circles. The author, from a mass of varied material available, and from experience in various foreign laboratories, has compiled a concise, readable treatise, the outstanding feature of which is the way in which the essential information on each point has been condensed and clearly put. In 1906 the author was commissioned to go to Paris and familiarise himself with metallographical investigations being conducted there, and he began his researches under the guidance of M. Pourcel, the well-known metallurgist of Terrenoire. Following this the author pursued his studies in other prominent laboratories, thus getting into touch with the best modern practice. Owing to these advantages, the treatise offered has been brought quite up-to-date. At the conclusion of each chapter is given a bibliography of works on the subjects treated. The preparation of samples receives brief treatment, after which are given a few notes on metallographical examination. The components of ferro-carbon alloys are briefly described, a short chapter also dealing with the equilibrium diagram. Four interesting micrographs illustrate the chapter on the microstructure of iron. Carbon steel comes in for fuller treatment, a number of micrographs being used for illustrating the subject, while the same also applies to the chapters on ternary and quarternary steels. The structure of cast-iron as seen under the microscope is briefly explained, and the difference between white and grey iron clearly shown in the micrographs. Some interesting notes on malleable cast-iron, and a chapter on the examination of steel conclude the book. While in no sense exhaustive in detail, this little volume is certainly very comprehensive in the way in which it covers the subject, and the translator has rendered a service in placing the work of the Italian author before us.

An invention of considerable interest has recently been patented by a Norwegian gentleman, named Hans Peter Hansen, of Newcastle. The invention consists of a process by which wooden pipes and tubes are manufactured from shavings and solution. Extensive and thorough tests of the new material have been made with satisfactory results. As to the purposes to which the new pipes and tubes can be adapted, a few may be instanced. As a conduit for electrical wires, to replace metal pipes for the conveyance of water and liquids—especially in cases where metal pipes would be subject to corrosive acids; as pipes for compressed air; as ventilating pipes, gas pipes or temporary pipes for builders' contractors; as speaking tubes on vessels or in buildings; as a non-conductive covering for steam-pipes; for all these purposes the wooden tube has been proved to be suitable.

Inventions.

Applications for Patents.

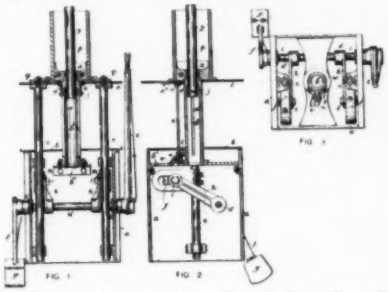
An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

6,372. Casting syphon heads, etc. J. Reichl and P. Benzinger.
6,374. Manufacture of hardenable steel. W. S. Simpson, 173, Fleet Street, London.
6,485.*Process for improving alloys. A. Wilm.
6,496.*Gas-fired furnaces. F. W. Sandmann, 39, Victoria Street, Westminster.
6,523.*Alloy for electric soldering tools. Regina-Bogenlampenfabrik G.m.b.H., 285, High Holborn, London.
6,553. Electric welding. S. Jevons and V. D. Green, 75, New Street, Birmingham.
6,643.*Furnaces. A. Hamilton, R. Hamilton, and A. Hamilton.
6,768.*Electric furnaces and the method of charging the same. Stora Kopparbergs Bergslags Aktiebolag.
6,780. Alloys. J. F. Duke.
6,790. Welding and cutting of metals by means of blow pipes. K. S. Murray.
7,024.*Alloys and process of making the same. R. R. Graf.
7,029. Crucible tongs. M. C. Inglis, 265, Strand, London.
7,198.*Casting metal plates, bars, etc. G. C. Fricker.
7,699. Manufacture or casting of iron, steel, and the like metals. J. E. Bennett, 4, Corporation Street, Manchester.
7,704.*Chamber and retort furnaces. C. Benninghoff and Firm August Klönne, 99, Guildford Street, London.
8,010.*Casting machines. J. Soss and A. W. Christianson.
8,335.*Expansive cores for moulds. P. C. Merillat.
8,402. Formation of moulds for casting in metal. W. Roxburgh and A. Forsyth, 148, Grosvenor Road, Rugby.
8,718.*Furnaces. J. Savary.
8,711.*Electric-resistance furnaces. A. Petersson.

Abstracts of British Patent Specifications recently accepted.

18,175 (1908). *Production of Alloys of Copper such as Brass.* W. R. Hodgkinson, Professor of Metallurgy at Ordnance College, 18, Glenluce Road, Westcombe Park, Blackheath, London, and S. C. Peck, 7, Nightingale Place, Woolwich.—The object of the invention is to improve the qualities of such alloys for certain purposes, by the introduction into the alloys of additional constituents, or of further quantities of the existing constituents, in the form of phosphides. Thus, for example, it is found that the introduction of various small proportions of chromium, manganese, nickel, cobalt, or zinc may alter the properties of the resulting alloy, and in certain cases render the alloys considerably more useful for certain purposes. In introducing a metal into a copper alloy such as brass, a portion of the alloy metal is heated with a solid reducing agent, such as carbon, and a phosphate of the metal to be introduced, so as to produce a metallic solution of the phosphide of the metal to be introduced, and thereafter this solution of phosphide may be added in any desired proportion to the molten alloy. The phosphorus may be partly or entirely volatilised with a portion of the metal of the alloy leaving the metal of the original phosphide in the alloy.

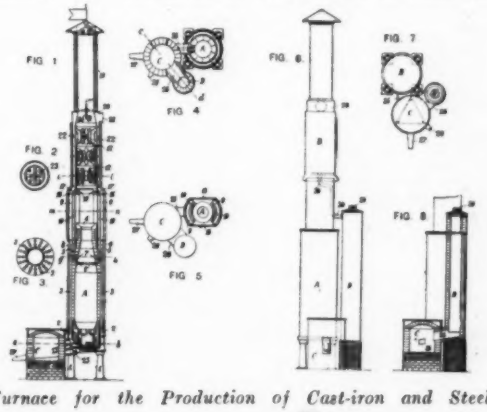
7,155 (1909). *Machinery for Making Cores for Foundry Purposes.* F. Penlington, 18, Station Road, Gorton, Manchester.—Figure 1 is a sectional front elevation of a machine constructed in accordance with the invention; Figure 2 is a sectional side elevation; and Figure 3 is a sectional plan on line 1, 2, of Figure 1. *a* represents the stationary framework of the machine, usually covered in at the top by a stationary sheet metal table *b* to protect the working parts below from sand, the framework being suitably bolted or stayed together. In the frame supported in bearings *c*, is a shaft *d* having at one end an operating lever *e* and at the other end a lever *f* formed in one with or carrying a balance weight *g*. The shaft has also fixed to it levers *h*, the free ends of which are provided with projecting studs *i* adapted to engage with slide blocks *j*



Machinery for making Cores for Foundry Purposes.

capable of sliding to and fro in slots *k* of arms *m* carried by or formed in one with vertically-slidable rods or bars *n*, the upper ends of which are secured to a table *o* adapted to carry one or more core boxes *p* of an interchangeable character, such boxes being secured to the table by screw clamps *q* engaging with flanges at their lower ends. Only one core box is shown, and this, as well as those which may be interchanged for it, may be of any suitable cross section, according to the character of the core to be produced. The box indicated is for making cores of circular cross section. The lever and slide mechanism described is for raising and lowering the table *o*, the first operation being accomplished previous to ramming the core box and the latter after such ramming has been completed to effect the stripping or ejection of the core.

14,351 (1909). *Furnaces for the Production of Cast Iron and Steel.* F. Resinelli, Vadoligure, Province of Genoa, Italy.—The invention comprises, in combination,



Furnace for the Production of Cast-iron and Steel.

a principal furnace, a shaft or chimney, a regenerator, a fore-hearth, and an auxiliary pre-heating furnace for heating reagents. Gases for heating the furnace last

mentioned are withdrawn from the fusion zone of the principal furnace, and returned to the chimney, whereby the pressure of the gases in the fusion zone is decreased. The invention also comprises a convenient form of regenerator adapted for present purposes, and provision is made for supplying combustible gases for heating the air passing through the regenerator in an improved manner so that flaming at the charging mouth, when the feed doors are open, is diminished or prevented. Figure 1 shows a vertical central section of the improved furnace; Figures 2, 3, 4 and 5 show horizontal sections taken on the lines *i—l*, *g—h*, *a—b*, and *m—n*, respectively of Figure 1; Figure 6 is a front view, and Figure 7 is a plan of the improved furnace; Figure 8 is a vertical section taken on the line *c—d* Figure 4. The furnace comprises four distinct parts, viz., a principal furnace A, a chimney B combined with a regenerator, a reservoir or fore-hearth C receiving the fused metals which are therein treated, with the usual reagents to carbonise or decarbonise the iron according to the desired qualities of the metal to be produced, and a furnace D for the preliminary heating of the reagents.

Trade Talk.

Messrs. Hamilton Brothers have moved to 182, West George Street, Glasgow.

Mr. A. Goldie Engholm, engineer, has removed to 104, Newhall Street, Birmingham.

Hadfield's Steel Foundry Company, Limited, are to supply the Sheffield Tramways Committee with special work for track renewals.

The Power Gas Corporation, Limited, Stockton-on-Tees, have opened a branch at Birmingham, with offices at 78, Shirley Road, Acocks Green.

Messrs. J. B. Corrie & Company, Queen Anne's Chambers, Tothill Street, Westminster, S.W., have removed to 15, Victoria Street, Westminster, S.W.

A fire broke out recently on the premises of Messrs. Pratchitt, ironfounders, Carlisle, totally destroying a shed containing a large number of patterns.

Nasmyth, Wilson & Company, Limited, of Patricroft, have opened a London office at 38 and 39, Parliament Street, S.W., which will be under the charge of Mr. Robert Dougal.

A dissolution of partnership is notified in connection with Messrs. J. Parkes and H. S. Pullen, mechanical engineers, Woodbridge, Suffolk, who traded under the style of Parkes & Pullen.

Godwin, Warren & Company, Limited, 140, Redcliffe Street Bristol, have been appointed sole selling agents for the "Kettering" brand of Northamptonshire pig-iron for the South-West of England.

The Radium Steel Company, Limited, which was registered in August, 1908, has recently gone into voluntary liquidation, and has appointed Mr. M. Webster Jenkinson, of Sheffield, as liquidator.

Julian Kennedy, Axel Sahlin & Company, Limited, have arranged to install the Gayley dry-air blast process at the works of the Oesterreichische Berg & Huettenwerks Gesellschaft in Teschen, Austrian Silesia.

During the height of the storm on April 18 a considerable part of the top of the chimney stack at the works of Messrs. Paul & McLachlan, ironfounders, Carronbank, Denny, was blown down and crashed through the roof of the moulding shop.

The London office of the Isca Foundry and Engineering Company, of Newport, Mon., has been removed to St. Margaret's Mansions, 53, Victoria Street, Westminster, S.W. Mr. J. Cawley is now the company's representative in London.

Crossley Brothers, Limited, Openshaw, are making extensive additions to their works. These include the erection of a shop some 300 feet long, which adjoins the workmen's dining hall and fronts upon Whitworth Street, and a large pattern shop and stores.

The firm of Simpson & Company, carrying on business as metal merchants at 19, Anderston Quay, Glasgow, of which Mr. Allan Simpson and Mr. Robert Edward Davidson were the sole partners, has been dissolved. Mr. Allan Simpson will discharge the liabilities.

Browett, Lindley & Company, Limited, engineers, of Patricroft, near Manchester, who have secured several important contracts, including one for railways in the Argentine, are opening up agencies in South Africa, Egypt, Argentine, Japan, China, Spain, and Australia.

The Denby Iron and Coal Company, Limited, Derby, have appointed Messrs. Bernard Holland & Company, engineers, 17, Victoria Street, Westminster, S.W., as their agents in London and surrounding districts, including Swindon, Portsmouth, Bedford, and Ipswich, also for export work.

J. & C. Swanne, Limited, steel and iron merchants, 11, Warwick Chambers, Corporation Street, near New Street, Birmingham, have been appointed the sole agents for the Birmingham district for the Weardale Steel, Coal and Coke Company, Limited, of Spennymoor, for the sale of their pig-iron.

Messrs. Wm. Hodgson & Sons, the partners of which company were connected with Hodgson & Stead, Limited, Windsor Street, Salford, have established themselves in West High Street, Salford, Manchester, where they are putting down a plant for the manufacture of every description of weighing machinery.

The Mining and Metallurgical Club has been established in premises adjoining St. Ermin's Hotel, Westminster, London, S.W. Messrs. S. H. Farrar, W. McDermott, E. Taylor, A. C. Claudet, and H. L. Sulman have been appointed the first finance committee, with Mr. C. McDermid as honorary secretary.

Before the members of the Sheffield Society of Engineers and Metallurgists, on April 18, a lecture on "A Heat Treatment study of some Chromium Steels" was given (as a private communication to the members), by Professor A. McWilliam and Mr. E. J. Barnes. Mr. J. Rossiter Hoyle (president of the society) occupied the chair.

Messrs. Douglas & Grant, Dunnikier Foundry, Kirkcaldy, have secured the sole right for the manufacture and sale in the United Kingdom and the Colonies of Carels' drop valve steam engine. Messrs. Carels were among the pioneers in the use of highly superheated steam for either reciprocating or rotary engines.

Messrs. Weager & Funck, proprietors of the Metal and General Agency, of 5, Whittington Avenue, London, E.C., are now prepared, on behalf of their principal, Mr. A. Neusester, of Brussels, to enter into contracts for constructional work of all description, including material for iron buildings, tubes, castings, stamped plates, corrugated sheets, etc.

An important feature of the manufacturing changes recently carried out at the works of Kynoch, Limited, is an extension of general foundry work. A new foundry has been started to deal with the casting of grey iron of general descriptions, for a variety of purposes, and to do jobbing work generally. It is proposed also to do a considerable amount of work in steel.

Messrs. David Brown & Sons (Huddersfield), Limited, of Huddersfield, are transferring their East Parade Pattern Works to Lockwood, where new shops covering an area of 14,000 square feet are being erected alongside their foundry and gear works. These new premises, which include extensive stores, drying sheds, stoves and timber yard, will be equipped with the latest woodworking machinery.

The Underfeed Stoker Company have appointed Mr. A. A. Tasker, of 110, Queen Street, Cardiff, as their sole representative for South Wales in place of Messrs. Haslam & Schontheil, who have relinquished the agency. Messrs. Haslam & Schontheil are not, however, giving up all connection with the Underfeed

Stoker Company, as they will attend to any inquiries received.

THE firm of Kerr & Crawford, engineers and machinery agents, 145, Bath Street, Glasgow, of which Mr. Norman Kerr and Mr. James Forrester Crawford were the sole partners, have sold their business to Messrs. Alston & Blyth, colliery and engineers' furnishers, 99, Waterloo Street, Glasgow. The business will be carried on by Messrs. Alston & Blyth in their own name at 99, Waterloo Street, Glasgow.

THE quarterly ascertainment under the sliding scale in force between the Cumberland iron masters and the blastfurnacemen shows that the average selling price of pig-iron warrants has been 65s. Blastfurnacemen's wages are to be, therefore, 31¼ per cent. above standard, this being an advance of 6¼ per cent. compared with the previous quarter, and of 13½ per cent. compared with the corresponding quarter of last year.

MR. LESLIE S. ROBERTSON, the secretary of the Engineering Standards Committee, states that the Government have intimated their willingness to contribute £500 a year for three years to the committee. The Secretary of State for India in Council has also made a grant to the committee of £300 towards the expenses incurred in the preparation of the Third Report on Standard Locomotives for Indian Railways.

MESSRS. J. E. ERNEST & EDWARD ROBINSON, late with John Robinson, Engineers, Limited, Old Lane, Openshaw, have purchased a portion of the works formerly in the occupation of the Haste Pump Company, Grey Street, Openshaw, where they are trading as M. E. Robinson & Company. At the present time the works are being fitted up for the manufacture of steam engines, mill gearings, and general millwrighting.

MESSRS. DENNY & COMPANY, engine manufacturers, Dumbarton, were, at the local Dean of Guild Court, on March 28, granted permission to make very important additions to their premises. The extension comprises a large machine shop, a small machine shop, and a valve shop. A rough estimate of the cost of the extension is £50,000. The contract for the work has been placed with Messrs. Sir William Arrol & Company, Glasgow.

THE annual meeting of the Society of Chemical Industry (Birmingham and Midland Section) was held recently at the University Buildings, Birmingham. Dr. T. Slater Price presided. A paper was contributed by Messrs. A. R. Warne and W. S. Davey on "Industrial Corrosion of Iron." The writers stated that they recently made a study of the corrosion of tar stills. To the tar distiller the corrosion of his stills was a continual source of anxiety and expense, and he would welcome the day when an alloy of reasonable price was placed on the market that would resist for a longer period than wrought iron or mild steel the corrosive action of the vapours given off during the distillation of tar.

W. & T. AVERY, LIMITED, of the Soho Foundry, Birmingham, are exhibiting at the Buenos Aires Exhibition an interesting collection of weighing machinery specially suitable for South America. These include a combined weighbridge for weighing trains of mixed trucks while in motion, which consists of two weighbridges having a capacity of 40,000 kilogs each or 80,000 kilogs combined; while a specially patented arrangement styled lead-on-rails allows the weight to be gradually placed on the weighbridge itself and so prevent any shock to the wearing parts and a steady movement to the indicating finger. Other exhibits include a weighbridge for weighing cattle, luggage weighing machine, portable platform machines, and crane of suspended weighing machines.

MR. H. WARINGTON SMYTH, Secretary for Mines, Pretoria, recently issued a notice to the effect that the Transvaal Government were prepared to receive proposals for the erection of plant for the manufacture of steel from iron and steel scrap. Arrangements will be made whereby the successful applicant will be entitled to purchase accumulation of Central South African Railways scrap now lying at Pretoria, amounting approximately to 15,000 tons, at the price of £1 per ton, and in addition not less than 500 tons of the scrap produced annually for a period of five years at the same price; any scrap required for railway shop purposes will be excluded from above arrangement. For purposes of encouraging the industry the Government will be prepared to consider favourably any readjustment of railway rates to facilitate the transport of scrap to the steel works and to discourage its export.

A CIRCULAR has been issued to the shareholders of Robert Stephenson & Company, Limited, by Mr. W. B. Peat, the receiver and manager, which, in effect, declares, that in the opinion of that official, reconstruction of the company on the basis of continuing its position as a whole under its existing name is impossible, as the shipyard department will require financial support, which is not now obtainable. The engine works at Darlington, it is declared, could be advantageously converted into a separate concern, in which the shareholders might be invited to take an interest. Holding this view, Mr. Peat believes it to be prudent that the shipyard should not be carried on, but should be disposed of, and that the engine works should be continued. It is, therefore, proposed that the Darlington works should be turned into a separate concern, and that the shipyard, graving dock, boiler foundry, and other shops at Hebburn should be sold by private treaty.

THE greatly increased activity in engineering and foundry work in the Birmingham district has concentrated particularly upon firms devoted to the equipment of iron and steel mills. It is a long time since such typical establishments as Akrill, Limited, Josiah Guest & Son, and Bayliss, Jones & Bayliss, were so busy with this class of work. Some very heavy rolls have been sent to the North of England for the equipment of cogging mills and mills devoted to shipping material and heavy sections. A disadvantage much felt is the unsatisfactory selling price, profit margins being very narrow. It was expected that at the Quarterly Meeting an advance would be declared, but according to a long-established tradition, ironfounders follow movements in marked bars, and the expected advance in this section was not made largely owing to the wide margin that exists between unmarked and marked bars. Probably an advance will be declared shortly, as for some time past the best qualities of foundry iron have been steadily rising in price.

THE new schedule of definition of iron and steel, which a committee of the International Association for the Testing of Materials proposes to establish, will probably be opposed by the representatives of the Sheffield steel trade at the May meeting of the Iron and Steel Institute in London. A paper on the subject will be read by Professor J. O. Arnold, of Sheffield University. A large and representative meeting of Sheffield steel makers was held on April 18, Mr. Herbert Barber (master cutler) presiding, to consider the question. The committee of the International Association for Testing Materials, to which has been allocated the duty of codifying and revising all the names and constituents of iron and steel in their various forms, has included in its proposals one that blister steel, a name hitherto given in the Sheffield trades to cemented Swedish wrought iron or other wrought iron of similar quality, should in future be held to cover as a definition "steel made by carburizing wrought iron by heating it in contact with carbonaceous matter, which may be made by carburizing a low carbon steel." This proposition was laid before the congress of the International Association for Testing Materials in 1909 at Copenhagen. The congress, while approving much of the report, referred back to the committee for revision that portion which referred to blister and shear steel, and to which Sheffield manufacturers now take objection. Professor Arnold pointed out at a recent meeting the objectionable features of the proposal to temper with the composition of blister steel, or to permit inferior grades of material being introduced into the trade with impunity. He showed how the proposal affected blister steel itself, and how ultimately it would involve the quality of both shear and crucible steel. It was stated that the report was now under revision, and that a committee of the International Association had asked for comments on

the proposal. The following committee was appointed to watch over the interests of the Sheffield crucible steel trade and to make all the necessary communications with the International Committee:—The Master Cutler, Mr. W. F. Osborn, Mr. Sydney J. Robinson, Sir Joseph Jonas, Mr. W. F. Beardshaw, and Mr. J. Rossiter Hoyle. It should be remembered, however, that as the report of the International Association was not adopted, the functions of the Committee will be to watch future proposals rather than to condemn past ones.

Deaths.

THE death is announced of Herr Hanns Jencke, who for many years was one of the chief officials of the Krupp Works at Essen.

THE death occurred recently of Mr. George Albert Shipman, managing director of the firm of Messrs. George A. Shipman & Company, Limited, steel wire manufacturers, Sheffield.

THE death is reported of Mr. W. P. Bullivant, head of the firm of Messrs. Bullivant & Company, wire-rope manufacturers, of Mark Lane, E.C., at the age of 52 years.

MR. J. HARROP died at his home, "Brondeg," Pontardulais, on March 28. The deceased gentleman was formerly managing director of the Gravesend Steel and Tinplate Works, and one of the best-known and respected men in the South Wales tinplate trade. He was sixty-nine years of age.

MR. J. WALKER died at Ilkley, on April 2, in his 91st year. He was second and last surviving son of Mr. Mark Walker, engineer, who in the early part of last century was a partner in Messs. Lawson & Walker, ironfounders and machine makers, Mabgate, Leeds.

THE death occurred on April 5 at his residence, Remswell, Stockton, of Mr. W. Anderson, J.P., aged 73 years. The deceased, who was trained at the Elswick Works, was employed during the construction of the first Armstrong gun. He had, since 1870, been associated with the works of Head, Wrightson & Company, Limited, engineers, Thornaby-on-Tees, of which he was one of the managing directors. He took an active part in public life, and was the first Mayor of Thornaby.

MR. ALLAN ANDREWS, engineer, Kilmarnock, died at his residence recently in his 90th year. A native of the town, Mr. Andrews was for a time associated with Mr. Andrew Barclay, who founded the Caledonia Works, and later he started for a company the Britannia Engineering Works, of which he acted as manager. More than 30 years ago he commenced business on his own account as a consulting engineer. He was an expert in mining machinery, and had a large connection.

Legal.

Power of Railway Companies to Increase Rates.

The Railway and Canal Commission, consisting of Mr. Justice A. T. Lawrence, Hon. A. E. Gathorne Hardy, and Sir James Woodhouse, had before them on April 18 the consideration of the report of the Registrar on a finding of the Court in favour of the applicants, in the case of the Beeston Foundry Company against the Midland, London and North-Western, and Lancashire and Yorkshire Railway Companies. The case, as originally brought up, was on an application by the Foundry Company that the railway companies should cease to overcharge them on the carriage of radiators and for the return of the overcharges already made. Up to the year 1896 the railway companies charged radiators as "bundles of pipes," which were classified in class "C." In that year they discovered that radiators had not been classified by the Board of Trade, and they thereupon removed them to another category upon which they charged a higher rate. In 1901 the railway companies put radiators in still another category and charged a yet higher rate.

Mr. Clements, for the applicants, claimed, upon the report of the Registrar, that his clients were entitled to recover overcharges from the time the radiators had been removed from class "C" in 1896.

Mr. Simon, K.C., on the contrary, submitted that the finding of the Commission was clearly that no illegal charges had been made until the second increase of rates in 1901. He also submitted that a counterclaim made by the railway companies for £1,173 should be governed by the finding of the Court, as he interpreted it.

Mr. Justice A. T. Lawrence adopted the interpretation of the finding of the Court advanced by Mr. Simon, saying their finding was that the railway companies when they discovered that radiators were not classified were justified in charging higher rates in 1896, but that, having then classified the freight themselves, they were not justified in removing them into another classification in 1901, at a still higher rate. The decision of the Court, he added, was given without prejudice to any classification of radiators which might be made by the Board of Trade on an application which, he understood, had now been made to them by the railway companies.

Mr. Clements said the suggestion made by Mr. Simon had been sprung upon him without notice, and he was hardly prepared to meet it.

His Lordship thereupon said the case could be adjourned to allow him to consider the matter. He added the suggestion that the parties should in the meantime endeavour to make some arrangement upon the counterclaim.

Mr. Clements submitted that the railway companies had not even asked for judgment on that, and that the Court not having pronounced upon it it was gone.

Mr. Macassey, for the railway companies, said in that event the only thing left to the railway companies was to bring an action at common law.

The case was adjourned.

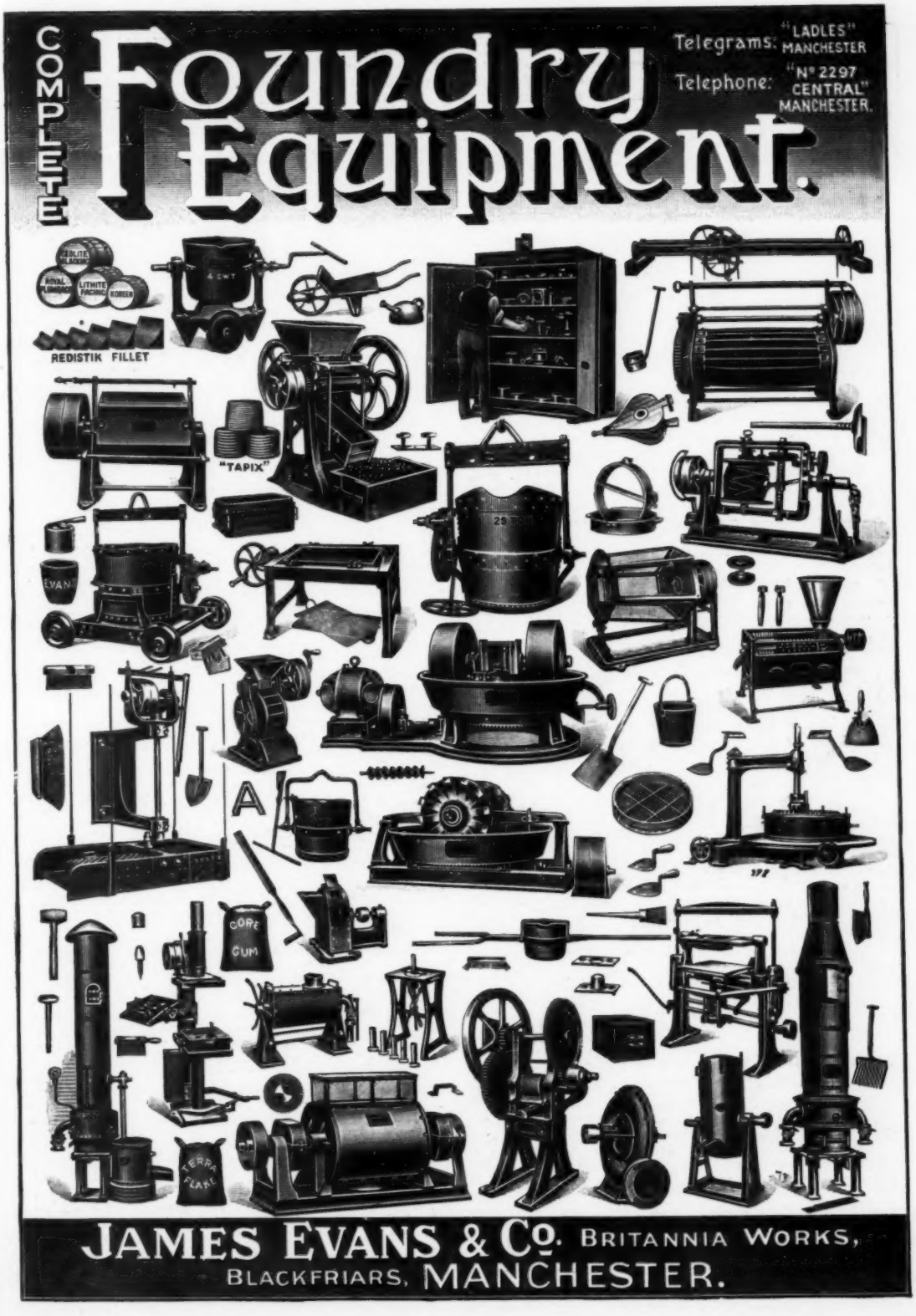
Death from Ferro-Silicon Fumes.

In the Court of Appeal on April 12, before Lords Justices Vaughan-Williams, Fletcher Moulton, and Farwell, the case of Frances Bamfield *v.* the Goole and Sheffield Transport Company, Limited, came on for hearing, on the appeal of the defendants from a judgment of Mr. Justice Walton, at the Leeds Assizes. The action was one for damages, brought by the widow of William Bamfield, who died from the effects of fumes given off by a cargo of ferro-silicon, a substance used largely in the manufacture of steel. The defendants, in pursuance of a contract which they made with the Lancashire and Yorkshire Railway Company to carry from the steamer "Nidd" at Goole to Sheffield 31 casks of ferro-silicon hired Bamfield and his canal boat to do the job. Soon after the journey began Bamfield, his wife, and their little grandson, were taken ill as the result of the fumes from the cargo, and unfortunately Bamfield and the little boy died. At the trial Mr. Justice Walton found that there was in law a warranty by the shippers of the goods that they were fit to be carried, and he gave judgment for the plaintiff, with damages amounting in all to £325. The defendants now appealed.

Mr. Tindal Atkinson, K.C., for the appellants, submitted that there was no such warranty as that found by the learned Judge. It was proved at the trial that only ferro-silicon of a certain nature gave off these dangerous fumes. The occasions, since 1904, on which ferro-silicon had given rise to trouble, were very rare. He submitted that in the circumstances no case had been made out against the defendants.

Mr. Lowenthal, for the plaintiff, submitted that the judgment of Mr. Justice Walton was right. Even if Bamfield had been told that the cargo was ferro-silicon that was not enough, as nothing was said as to its dangerous character.

The hearing was adjourned.


COMPLETE
Foundry Equipment.
Telegrams: "LADLES" MANCHESTER
Telephone: "N° 2297 CENTRAL" MANCHESTER.
REDISTIK FILLET
"TAPIX"
EVAN
CORE GUM
TERRA FLAX
JAMES EVANS & Co. BRITANNIA WORKS,
BLACKFRIARS, MANCHESTER.

New Companies.

MERRYLEES & COMPANY, LIMITED.—Capital £5,000 in £1 shares, to carry on the business of ironfounders, etc., and to acquire that carried on at Liverpool as Merrylees & Company.

WM. ELDER & SONS (GLASGOW), LIMITED.—Capital £3,000 in £1 shares, to carry on the business of ironfounders, mechanical engineers, etc. Registered office: 23, Bellgrave Street, Glasgow.

CHADDESLEY MANUFACTURING COMPANY, LIMITED.—Capital £25,000 in £1 shares, to take over the business of an engineer, iron and steel worker, etc., carried on by F. W. Brampton, near Kidderminster.

FOSTER & PULLEN, LIMITED.—Capital £5,000 in £1 shares, to acquire the business of lighting specialists and brass founders and finishers, carried on by Messrs. W. Grange and H. Pullen, at Bradford, as Foster & Pullen.

A. SEWARD & COMPANY, LIMITED.—Capital £10,000 in £1 shares, to carry on the business of a heating and ventilating engineer, etc., carried on by C. F. Seward as A. Seward & Company, at Market Street and Sun Street, Lancaster.

LOVIS PATENT PROPELLER SYNDICATE, LIMITED.—Capital £1,400, in £1 shares, to carry on the business of marine, electric, and mechanical engineers, etc., and to adopt an agreement with A. Allport, P. C. Tarbutt, and W. F. Hobdell.

SWIFT & HOUSE, LIMITED.—Capital £10,000 in £50 shares, to take over the business of engineers, ironfounders, mechanical engineers, etc., carried on by H. Swift and T. E. House, at Union Foundry, Newton, Wigan, as Swift & House.

ROBINSON'S HASTE ENGINEERING COMPANY, LIMITED.—Capital £2,000 in £1 shares, to take over the business of engineers, carried on at Openshaw, Manchester, as John Robinson, Engineers, Limited, and to adopt an agreement with D. Green, J. Mallinson, and W. Marchant.

E. H. SHORLAND & BROTHERS, LIMITED.—Capital £10,000 in £1 shares, to take over the business of a warming and ventilating engineer carried on by F. H. Shorland at the Manchester Stove Works, Oldham Road, Failworth, near Manchester, as E. H. Shorland & Brother.

BLUNDELL'S LONDON COPPER AND BRASS WORKS.—Capital £3,000 in £1 shares (2,000 "A" and 1,000 "B"), to carry on the business of general engineers, coppersmiths, founders, etc., and to adopt an agreement with T. A. Compton, Senr. Registered office: 23 and 25, West India Dock Road, E.

STEPHEN COTTON & COMPANY, LIMITED.—Capital £20,000 in £1 shares, to take over the business of a machine maker, iron and brass founder, electrical engineer, etc., carried on at Sydney Street, W., Belfast, by Chas. C. Cotton, J. S. Cotton and H. C. Kennedy. Registered office: Sidney Street, W., Belfast.

HIGHWAY, ANDREWS & COMPANY, LIMITED.—Capital £2,000 in £1 shares, to take over the assets used in connection with the business of ironfounders carried on at the Stella Works, Phœnix Street, West Bromwich, by Whale, Highway & Wilkes, and to adopt an agreement with W. J. Jennings and J. L. Andrews.

VANADIUM STEEL COMPANY, LIMITED.—Capital £3,000 in £1 shares, to acquire the works and business of Sydney Myers Schindler, trading as the Vanadium Steel Company, steel manufacturers, at 58, Foster's Buildings, High Street, and 6, Union Street, Sheffield. Registered office: 58, Foster's Buildings, High Street, Sheffield.

HESKETT STEEL CASTINGS (BRITISH), LIMITED.—Capital £10,000 in £1 shares, to acquire, deal with and turn to account Patent No. 16,940 of 1909, for United Kingdom, in respect of an invention for improvements in the conversion of iron and steel by the Bessemer method. Registered office: 17, Victoria Street, Westminster.

PONTELEC WELDING PATENTS, LIMITED.—Capital £30,000 in £1 shares (10,000 7 per cent. cumulative preferred), to acquire and turn to account any invention relating to electric welding of steel and other metals or any apparatus and machinery therefor, and to adopt an agreement with the Universal Electric Welding Company of America, and others.

HAMMOND & CHAMPNESS, LIMITED.—Capital £4,000 in 3,700 preference shares of £1 each and 6,000 ordinary shares of 1s. each, to take over the business of engineers carried on by Hammond & Champness at Kent Engineering Works, Alfreton Street, Old Kent Road, S.E. Registered office: The Kent Engineering Works, Alfreton Street, Old Kent Road, S.E.

SOCIETY OF ENGINEERS (INCORPORATED).—Registered with 1,000 members, each liable for £1 in the event of winding-up, to take over the assets and liabilities of the unincorporated societies known as the Society of Engineers (established 1854) and the Civil and Mechanical Engineers' Society (founded 1859). Registered office: 17, Victoria Street, Westminster, London, S.W.

JOSEPH STUBBS, LIMITED.—Capital £150,000 in £1 shares (25,000 preference), to take over the business of machine and tool makers, iron and brass founders, millwrights, etc., carried on at Ancoats and Higher Openshaw, Manchester, as Joseph Stubbs, and to adopt an agreement with W. T. Stubbs, J. H. Stubbs, and R. O. Stubbs. Registered office: Mill Street Works, Ancoats, Manchester.

CARMICHAEL BROTHERS, LMIMITED.—Capital £3,000 in £1 shares, to take over the business of an ironfounder, engineer, and ship repairer, etc., carried on by J. D. Carmichael, at Wapping Street, South Shields, and elsewhere, together with the interest of T. S. Carmichael and W. H. Withell in a plot of freehold land, with premises thereon, in and near Nile Street and Commercial Road, South Shields.

RUSSIAN GRIFFIN ENGINEERING COMPANY, LIMITED.—Capital £3,500 in 3,400 ordinary shares of £1 each, and 2,000 deferred shares of 1s. each, to take over the business of consulting engineer and machinery merchant carried on in Baku by F. P. Delacour, including particularly an exclusive agency for the sale in the Russian Empire of the Griffin liquid fuel, crude oil and gas engine. Registered office: 4, Lloyd's Avenue, E.C.

GEORGE TURTON, PLATTS & COMPANY, LIMITED.—Capital £45,000 in £1 shares (15,000 preferred), to carry on the business of manufacturers of springs, buffers, couplings, rail fastenings, etc., to acquire the business carried on at Savile Street and Furnival Road, Sheffield, as George Turton, Platts & Company, and to adopt an agreement with G. H. Cowen. Registered offices: Railway Buffer Steel Spring and File Works, Savile Street, Sheffield.

APPLEBY CRANE AND TRANSPORTER COMPANY, LIMITED.—Capital £150,000 in £1 shares (100,000 preferred ordinary and 50,000 ordinary), to carry on the business of makers of and dealers in electric and hydraulic cranes, hoists, lifts, and all kinds of lighting and conveying machinery, engineers, tool makers, etc., and to adopt agreements (1) with W. B. Peat as liquidator of Appleby's, Limited (in liquidation), and (2) with C. Appleby's, Limited (in liquidation), and E. G. Appleby. Registered office: 58, Victoria Street,

BRITISH ALUMINIUM COMPANY, LIMITED.—Capital £1,000,000 in £1 shares (300,000 preference), to acquire any minerals, clays, or other substances suitable for the production or manufacture of aluminium, sodium, iron or other metals, to carry on the business of miners, manufacturers of aluminium and its alloys, etc., to acquire and deal in any manner with all or part of the undertaking and assets of the Loch Leven Water and Electric Power Company, Limited, and to adopt an agreement with the British Aluminium Company, Limited (in liquidation).

SOUND

STRONG, CLOSE-GRAINED

CASTINGS

Obtained by using

"TITANIUM THERMIT"

TINS READY FOR USE. **ALL SIZES from 2 cwt. to 20 tons.**

Prices and Particulars from

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Telegrams: "FULMEN, LONDON."
Telephone: 3749 Central.

Works: **210a, Bow Rd., E.**

27, Martins Lane,
Cannon Street, E.C.

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE
BRITISH
ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Navigation Collieries, Ltd., Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years:—

Metals.	End April, 1910.	End Ayril, 1909.
Iron—Scotch pig warrants ton	*56/7½	*53.7½
—Middlesbro' warrants ... ton	50 4	47 7½
—W.C. M/nos Bessemer ... ton	69 0	57.0
—Stock, Scotch ... ... tons	1,000	1,000
Copper—Chili bars, GMB ton	£56 5 0	£56 5.0
—Stock, Europe and afloat tons	110,220	51,354
Tin—English ingots ... ton	£148 0.0	£134 0.0
—Straits ... ... ton	£150 7/6	£132 5.0
—Stock, London, Holland, U.S.A., and afloat ...tons	—	—
Lead—English pig ... ton	£13 0 0	£13 15.0
Spelter—Ord. Silesian ... ton	£22 2.6	£21 12 6
Quicksilver (75lb)... bottle	£9 0.0	£8 7.6
Antimony—Regulus ... ton	£29 0 0—£30 0.0	£30 0.0—£31 10.0

* Settlement price.

Castings.

In the Cleveland district the following are the nominal rates current for castings:—

	£ s. d.		£ s. d.
Columns (plain)	6 10 0	to	6 15 0
Pipes, 1½ to 2½ in.	4 17 6	to	5 2 6
,, 3 to 4 in.	4 10 0	to	5 0 0
,, 5 to 8 in.	4 7 6	to	4 10 0
,, 10 to 16 in.	4 7 6	to	4 10 0
,, 18 to 24 in.	4 7 6	to	4 10 0
Chairs	3 10 0	to	3 12 6
Floor plates (open sand)	3 2 6	to	3 5 0

Scrap.

The quotations for scrap, subject to market fluctuations, are as follows:—Heavy wrought (mixed), £2 9s. 0d.; light wrought, £1 7s. 6d.; heavy cast, £2 10s. 0d.; all per ton f.o.b., London. Copper (clean), £53 0s. 0d.; brass (clean), £38 10s. 0d.; lead (usual draft), £12 0s. 0d.; tea lead, £11 0s. 0d.; zinc, £17 15s. 0d.; all per ton delivered merchant's yard.

Personal.

Mr. J. Maclean Finlay has retired from the firm of J. F. Leggat & Finlay, engineers, 20, Lanark Street, Dobbie's Loan, Glasgow.

Mr. Vincent Cartwright Vickers, a director of Vickers, Sons & Maxim, Limited, has been elected a director of the Bank of England.

Mr. Thomas Warriner, chief marine engineer to the Thames Ironworks, Shipbuilding, and Engineering Company, Limited, has been added to the board of directors.

The late Mr. Joseph Harrop, formerly managing director of the Grovesend Steel and Tinplate Works, left estate valued at £13,131 gross, with net personalty £8,140.

Mr. Ben Hammond, who has been engaged with Messrs. Alldays & Onions, of Small Heath, has taken up the foundry foremanship of the General Electric Works, Witton.

The late Mr. J. H. Irwin, engineer, of The Gables, Ashbrook Range, Sunderland, a prominent member of the North-East Coast Institution of Engineers, left estate valued at £9,101 gross.

The late Mr. George Williams Hawksley, the founder of the firm of Hawksley, Wild & Company, Brightside Boiler Works, Sheffield, left estate valued at £447 3s. 6d. gross, and at £423 6s. net.

The gross value of the estate of the late Mr. W. Henshaw, of Wood Street, Willenhall, ironfounder, of the firm of Messrs. William Harper, Son & Company, is £9,005, of which the net personalty has been sworn at £8,835 2s. 6d.

Mr. Ben Hipkins, for some time past engaged at the large engineering establishment of Messrs. Bellis & Morcom, Birmingham, has accepted the foremanship of the foundry at the works of the Brush Electric Engineering Company, Loughborough.

Recently a number of the moulders employed at Messrs. Harland & Wolff's, Belfast, met to present Mr. John Hughes with a gold albert chain and pendant and a Gladstone bag, on his leaving to take up the position of foreman moulder at the company's repair shop, Southampton.

The late Professor Hilary Bauerman left £500 to the Memorial Fund of the Iron and Steel Institute. The residue of his property he left, subject to a life interest, upon trust to be applied by his trustees in the encouragement of the study of mineralogical science at the Royal School of Mines, by means of lectures on subjects of prominent or educational interest at the time, but which are not included in the ordinary list of subjects taught, and for making grants to enable students to make special investigations or to enable them to travel for the better pursuance of their studies.

Colonel T. E. Vickers, C.B., who lately retired from the chairmanship of Vickers, Sons & Maxim, Limited, has had a pension of £6,000 per annum conferred upon him in recognition of his life-long services to the company. The directors have elected Mr. Albert Vickers as chairman, and Mr. Arthur Trevor Dawson as managing director. Mr. Dunn has also resigned his directorship during the year, and has accepted a position as consulting naval architect to the company. The directors have filled the vacancies on the board by the appointment of Mr. Francis H. Barker, a director of Parsons' Foreign Patents Company, and Mr. James M'Kechnie, hitherto a special director of the Company for the Barrow Works.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

Established 1863.

JAS. DURRANS & SONS,

PHŒNIX WORKS, PENISTONE, Near Sheffield.

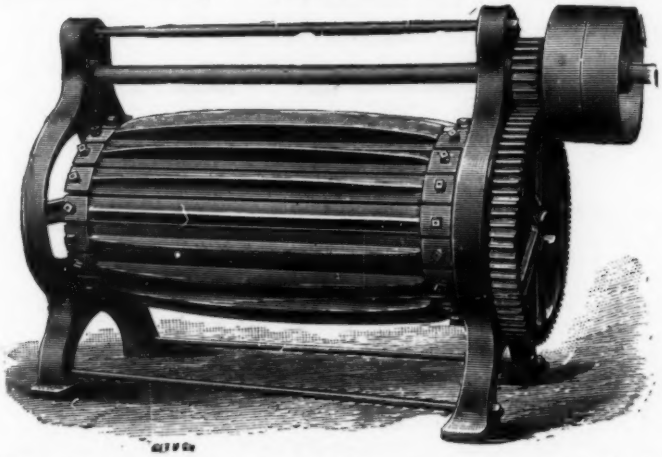
Manufacturers of all

FOUNDRY EQUIPMENTS,

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST.

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

IMPROVED FOUNDRY RATTLER or FETTLING DRUM.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD."

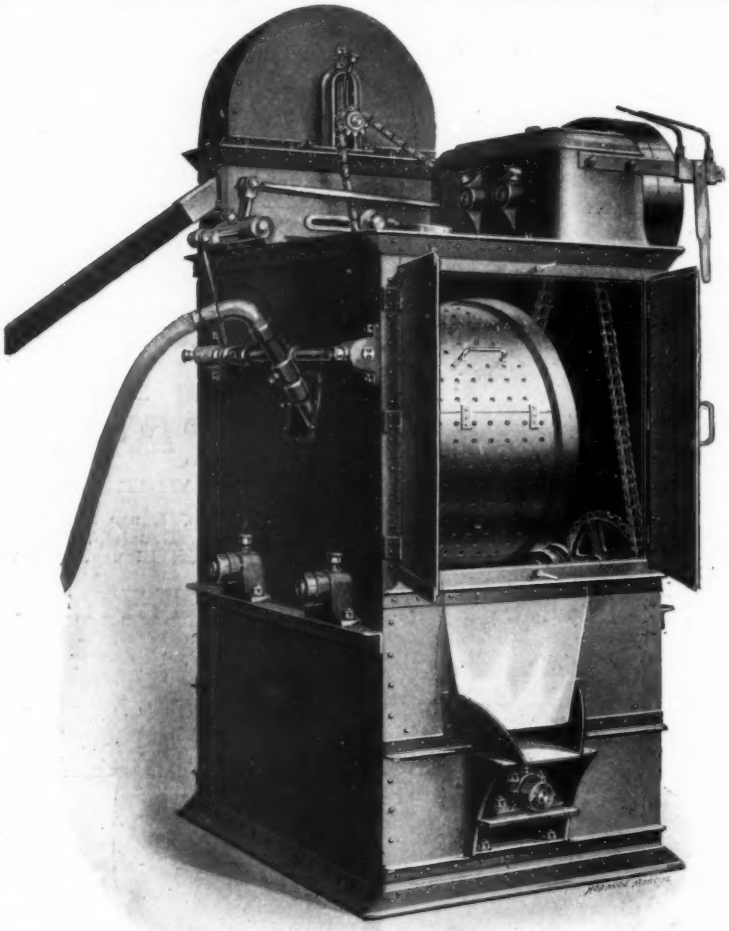
REDUCE YOUR CLEANING ROOM COSTS

BY USING

UP-TO-DATE

SAND-BLAST MACHINERY.

Give Castings better appearance.



Castings Machine quicker, Saves the machine tools.

Sand Blast Tumbling Barrel.

LARGE OUTPUT AT LOW COST.

MOULDING MACHINES, SAND PREPARING MACHINES.

THE LONDON EMERY WORKS Co.

PARK TOTTENHAM.
LONDON, N.

DEPARTMENT C1.

THE BUYER'S GUIDE

Addresses and further information will be found by reference to the Firm's Advertisement.

Abrasive Wheels.
London Emery Works Co.
Jackman, J. W., & Co., Ltd.

Air Compressors.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Electrically Driven).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Steam).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Belt).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Annealing.
Phillips, J. W. & C. J.

Ash Crushing and Washing Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Barrels (Tumbling).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.
Sonnenthal, Selig, & Co.
Tilghman's Patent Sand Blast Co., Ltd.

Barrows.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.

Bellows.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Durrans, Jas., & Sons.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Blacklead.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Blowers.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Buffalo Forge Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co., Ltd.
Phillips, J. W. & C. J.
Samuelson & Co., Ltd.
Sonnenthal, Selig, & Co.
Thwaites Bros., Ltd.
Ward, T. W., Ltd.

Buffing and Polishing Machines.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Sonnenthal, Selig, & Co.

Casting Cleaners.
Durrans, J., & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Pneumatic Engineering Appliances Co., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

Cement.
Dyson, J. & J.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Lowood, J. Grayson, & Co., Ltd.
Marshall & Co., Horace P.
Olsen, Wm.
Plasti-Kion Co.
Silent Machine and Eng. Co.

Chaplets and Studs.
Bush, Henry C.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Motherwell, Wm., & Co.
Olsen, Wm.
Wilkinson, T., & Co., Ltd.

Charcoal.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Walker, I. & I.

Charging Platforms.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Thwaites Bros., Ltd.

Coal Dust.
Cumming, Wm., & Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Coke (Foundry).
Elders Navigation Collieries.

Coke Breakers.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W., & C. J.

Core Boxes.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.

Core Compounds.
Bush, H. C.
Cumming, Wm. & Co., Ltd.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.
Wilkinson, Thos. & Co.

Core Gums.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Core Making Machines.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
Jones and Attwood.
London Emery Works Co
Marshall, H. P. & Co.
Phillips, J. W. & C. J.

Core Ovens.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Hislop, R. & G.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.
Phillips, C. D.
Phillips, J. W. & C. J.

Core Ropes.
Bush, Henry C.
City of London Wood Wool Co.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Wilkinson, T. & Co.

Core Vents.
Bush, Henry C.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Cranes.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Jackman, J. W., & Co., Ltd.
Vaughan & Son, Ltd.
Ward, T. W., Ltd.

Crucibles.
Hall, Charles, & Co.
Olsen, Wm.

Crucible Furnaces.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Simplex Coke Oven and Engineering Co., Ltd.

Crucible Furnaces (Lift-out)
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Phillips, J. W. & C. J.

Crucible Furnaces (Tilting)
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Crushing Mills.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Simplex Coke Oven and Engineering Co., Ltd.

Cupolas.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T. & Son.
Durrans, J. & Sons.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.
Marshall, H. P. & Co.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Cupola Linings.
Evans, J., & Co.
Harris & Pearson.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.

Emery Grinders.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davis, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.

Emery and Glass Cloth and Glass Paper.
London Emery Works Co.

Emery Wheels.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.

Fans.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Buffalo Forge Co.
Davies, T. & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Jenkins, W. J. & Co., Ltd.
Phillips, J. W. & C. J.
Sonnenthal, Selig, & Sons.
Thwaites Bros., Ltd.

Firebricks.
Durrans, J. & Sons.
Dyson, J. & J.
Harris & Pearson.
Jackman, J. W., & Co., Ltd.
King Bros.
Lowood, J. Grayson, & Co., Ltd.
Pearson, E. J. & J.
Silica Firebrick Co.

Foundry Blacking.
Bush, Henry C.
Cumming, Wm. & Co., Ltd.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Olsen, Wm.
Walker, I. & I.
Wilkinson, Thos. & Co., Ltd.

Foundry Brushes.
Bush, Henry C.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, C.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Phillips, J. W. & C. J.

Foundry Ladles.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Bush, Henry C.
Davies, T. & Son.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
McNeil, Chas.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Foundry Rattlers or Fettling Drums.
Alldays & Onions
Davies, T., & Son.
Durrans, J., & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.
Simplex Coke Oven Co. and Eng. Co., Ltd.

THE BUYER'S GUIDE.—*Continued.*

Foundry Sand.
Dyson, J. & J.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd
Wilkinson & Co., Thos., Ltd.

Furnaces (Annealing).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Hislop, R. & G.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Furnaces (Brass).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Furnaces (Melting).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.
Simplex Coke Oven and Eng. Co., Ltd.

Ground Gannister.
Durrans, J., & Sons.
Dyson, J. & J.
Evans, J., & Co.
Lowood, J. Grayson, & Co.
Silica Firebrick Co.
Walker, I. & I.

Grinding Machines and Tools.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Sonnenthal, Selig, & Co.

Hammers (Steam).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Thwaites Bros., Ltd.

Hay Band Spinnin Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.

Hoists.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Jackman, J. W., & Co., Ltd.
Marshall, H. P., & Co., Ltd.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Loam and Sand Mills.
Davies, T., & Son.
Durrans, J., & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Ward, T. W., Ltd.

Melting Furnaces (Oil fired).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Microscopes.
Swift, James & Son.

Mould Driers.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Moulding Machines.
Bush, Henry C.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.
Pickles, James.
Pneumatic Engineering Appliances Co., Ltd.
Samuelson & Co., Ltd.
Simplex Coke Oven and Eng. Co., Ltd.
Whittaker, Wm., & Sons, Ltd.

Moulding Machines (Hand and Power).
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.
Pickles, James.
Simplex Coke Oven and Eng. Co., Ltd.

Pig Breakers.
Evans, J., & Co.
Jackman J. W., & Co., Ltd.
Simplex Coke Oven and Eng. Co., Ltd.
Sonnenthal, Selig, & Co.

Pig-Iron.
Bradley & Sons, T. & I., Ltd.
Frodair Iron and Steel Co., Ltd., The
Goldendale Iron Co., Ltd.

Plumbago.
Bush, Henry C.
Cumming, Wm. & Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.

Plumbago—*cont.*
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Pneumatic Tools.
Jackman, J. W., & Co., Ltd.
Marshall, H. P. & Co.
Pneumatic Engineering Appliances Co., Ltd.
Simplex Coke Oven & By-products Co.

Polishing Sundries.
London Emery Works Co.

Publications.
Eagland & Co., Ltd.
Griffin, Charles & Co., Ltd.

Pyrometers.
Alldays & Onions
Phillips, J. W. & C. J.

Recording Gauges.
Evans, J. & Co.
Jackman, J. W., & Co., Ltd.
Phillips, J. W. & C. J.

Riddles.
Bush, H. C.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Simplex Coke Oven and Engineering Co., Ltd.
Wilkinson, Thos. & Co., Ltd.

Sand Blast Apparatus.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.
Tilghman's Patent Sand Blast Co., Ltd.

Sand Driers.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Phillips, J. W. & C. J.
Simplex Coke Oven and Eng. Co., Ltd.

Sand Grinding Mills.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.

Sand Mixers.
Evans, J., & Co.
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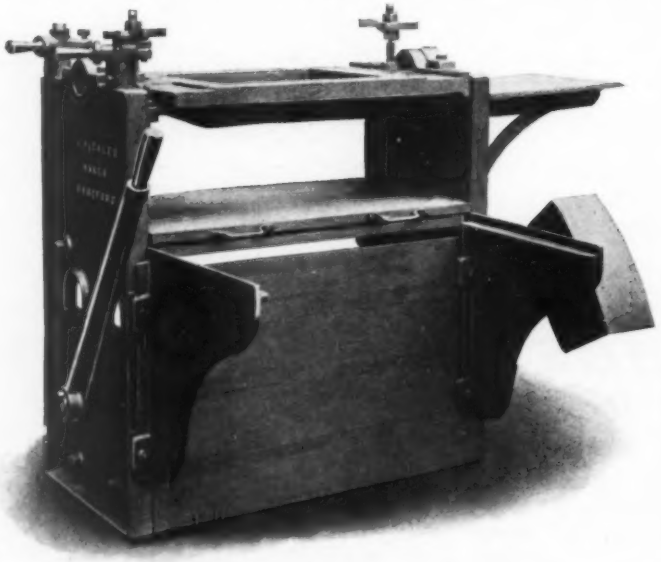

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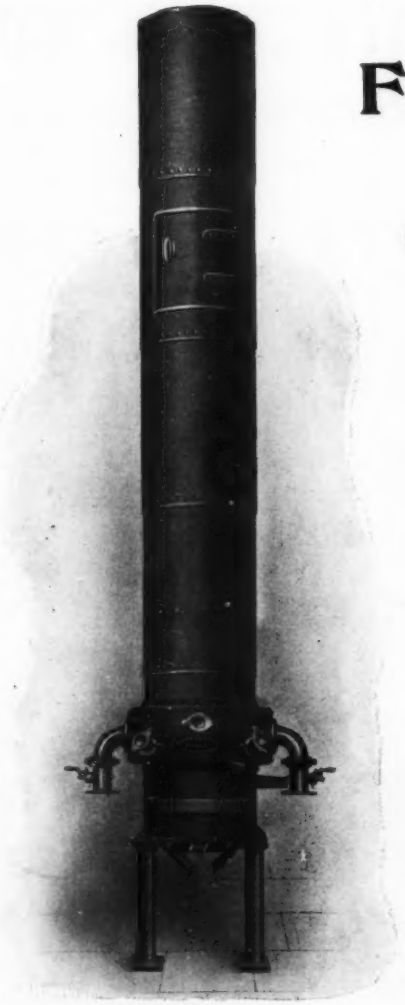

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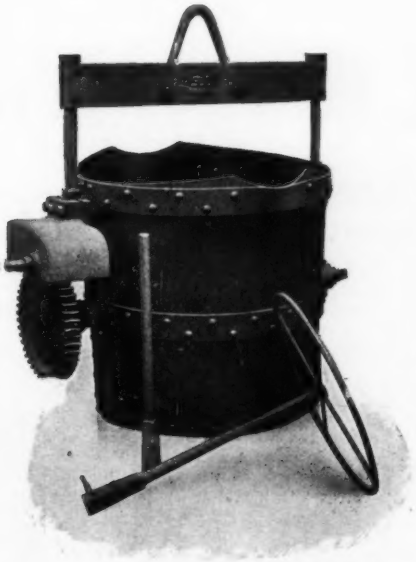

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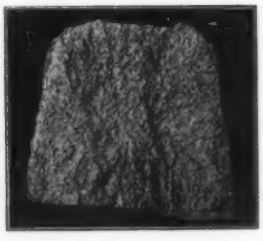
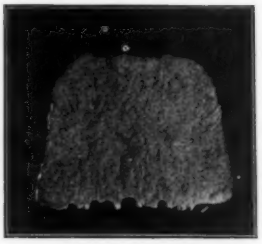

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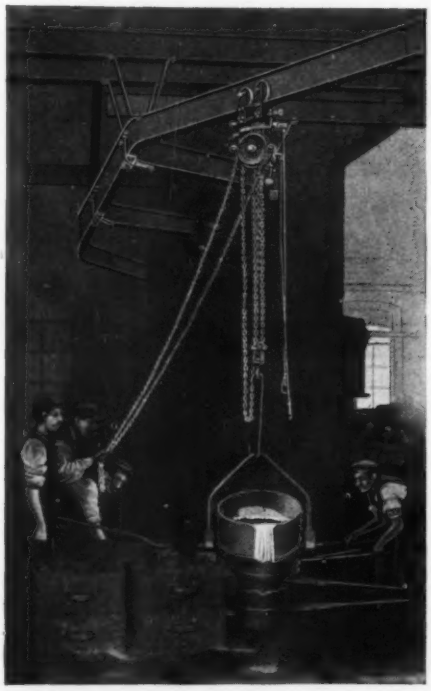

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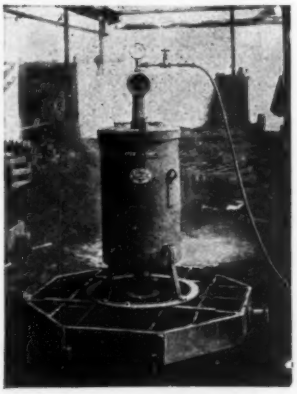

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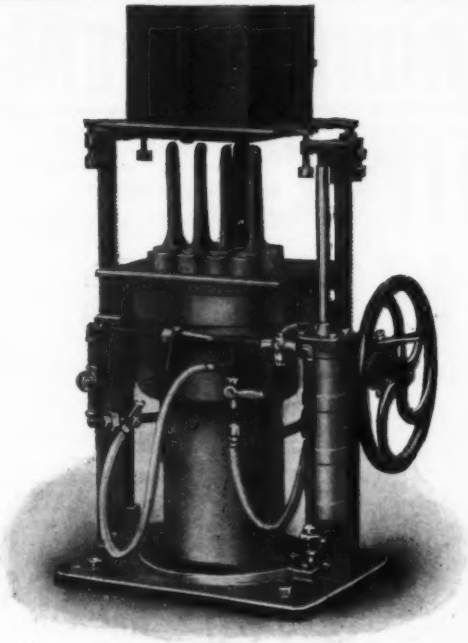

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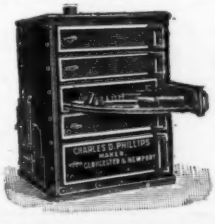

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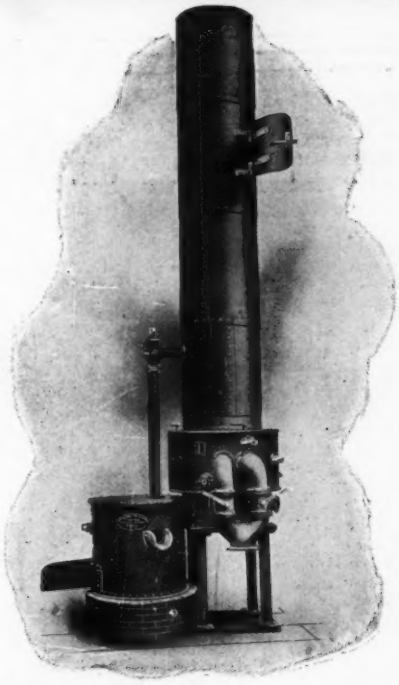

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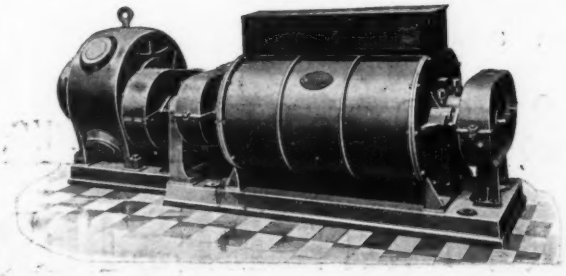

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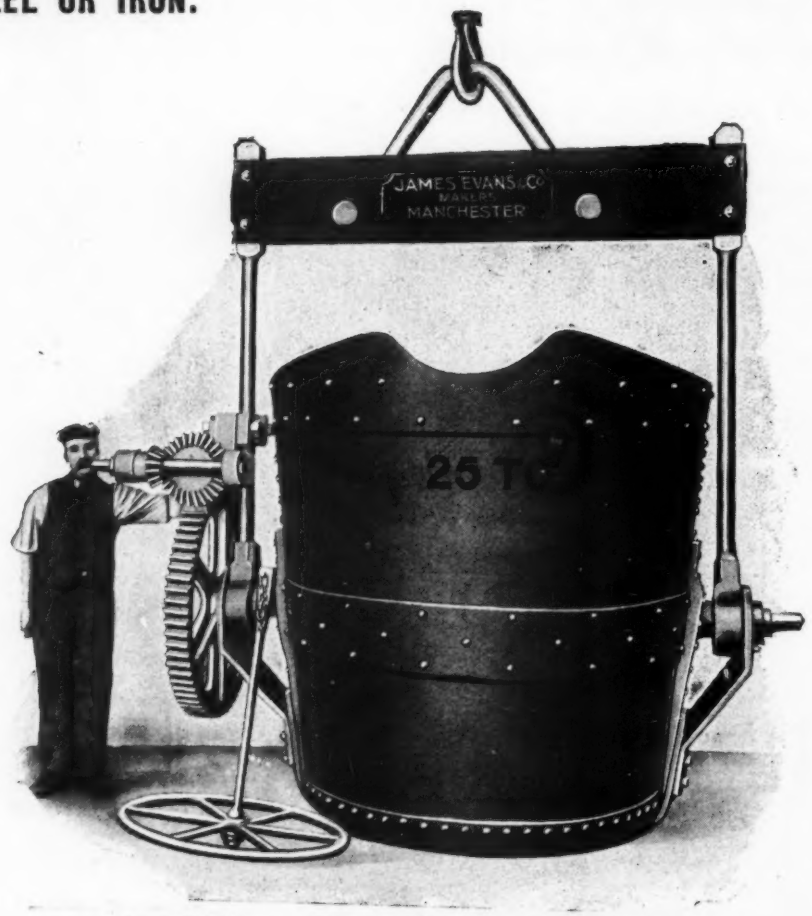

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